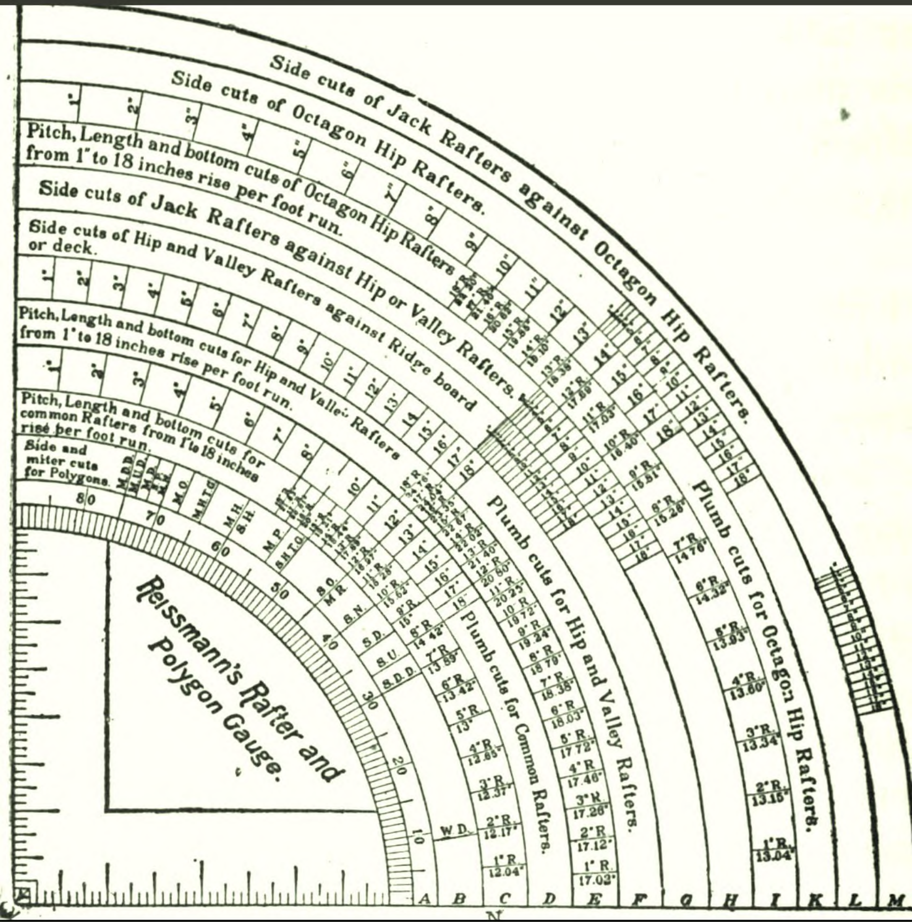

A Practical Treatise on the Steel Square and Its Application to ...

Fred T. Hodgson

A PRACTICAL TREATISE

ON

THE STEEL SQUARE

AND

Its Application to Everyday Use

BEING AN EXHAUSTIVE COLLECTION OF STEEL SQUARE PROBLEMS AND SOLUTIONS, "OLD AND NEW," WITH MANY ORIGINAL AND USEFUL ADDITIONS, FORMING A COMPLETE ENCYCLOPEDIA OF STEEL SQUARE KNOWLEDGE, TOGETHER WITH A BRIEF HISTORY OF THE SQUARE, AND DESCRIPTION OF TABLES, KEYS AND OTHER AIDS AND ATTACHMENTS

REVISED EDITION

IN TWO VOLUMES

BY

FRED T.homas HODGSON

Member of Canadian Association of Architects, Editor of "National Builder," Author of "Modern Carpentry," "Common-Sense Hand-railing" and other practical works on Building, etc.

VOLUME I

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PREFACE

In 1872 I contributed to a mecnanical journal a few short papers on "The Use of the Carpenter's Steel Square." A few years later, i.e., 1875-77, I wrote on the same subject a series of papers for "The American Builder," the most prominent building magazine at that time published in America. These papers, I am led to believe, were among the first that were ever issued devoted entirely to describing the uses and applications of the square, and so well did they meet with the appreciation of workmen who were interested in the steel square, that the writer was urged personally and by letters from all sides to put the papers in book form, and this was done in 1879, with the result that several hundred thousand copies of the work have been sold, and the demand has not yet decreased.

Since the first appearance of the little book above named the writer has been requested by hundreds of the readers thereof to still further pursue the subject and embody in one work all that is known of the square and that can be acccmplished with it so far as can be gathered

up to the present time. Partly in response to this request, and partly because I am informed of several other writers having intimated their intentions of filling the gap if I failed to do so, I have been persuaded to prepare the following volumes, which I hope will be of sufficient value and contain enough merit to warrant the appreciation of all workmen who may have on some occasion or other, to make use of the steel square.

It is not necessary for me in this preface to remind the young workman of to-day of the necessity of arming himself with all the resources of modern methods and appliances for the performance of his work, if he desires to stand in the front rank of his trade. This is so evident that he who runs may read it on every street corner. It is the bright, well-informed young man that wins the race, and the fellow who drops his tools at the first clang of the bell at quitting time and gives no further thought either to his work or his tools until the commencement of work again the following day, always remains at the foot of the ladder, and wonders how it is he does not prosper and thrive at the same rate as his more energetic and studious fellow workman. A few hours' quiet study each week during the winter nights

makes the difference between poverty and sufficiency, for be it known the employer soon discovers the superior qualities of the man who employs his brains as well as his hands in the performance of his duties, and advancement and higher pay are sure to follow sooner or later.

In the whole course of practice in the building arts there is no tool the artisan possesses that lends itself so readily to the quick solution of the many difficult problems of laying out work as the steel square. Therefore, it is essential the workman should have a thorough practical knowledge of its capabilities and applications, and it is to aid him in acquiring that knowledge that this work is prepared. It will be my endeavor throughout to place everything presented in as simple and plain a manner as possible, and avoid mystifying the workman with a redundance of formulae and figures, giving graphic explanations where possible, and cutting out surplus figures where such can be done without vitally affecting the sense of the subject under discussion.

As a matter of course I have drawn from many recent writers on the steel square, both as regards illustrations and descriptions, and in a number of instances it may be necessary for

me to repeat the solutions of some problems, showing different methods employed by different writers to arrive at the same results; and in doing this I am anxious to give credit to each individual whose matter I have made use of. It will be impossible, however, to give credit in each case, so I give the names herewith, and, should I omit any, I will be pleased to hear of them, and will see they are not overlooked in the next edition. The first in importance are J. O'Connell, St. Louis, Mo.; Wm. Croker, Orillia, Ontario; Wm. E. Hill, Terre Haute, Ind.; A. W. Wood, Lincoln, Neb.; F. Lascy, San Francisco, Cal.; J. P. Hicks, Omaha, Neb.; E. Stoddard, Indianapolis, Ind.; W. George, England; J. R. Gill, Hamilton, Ontario; W. G. Penrose, Trafford Park, England; H. Parker, England, and H. D. Cook, Philadelphia. Besides these a number of papers and magazines have been laid under contribution for matter and illustrations that are embodied in this work, among which may be mentioned the following: "The American Builder," "The Builder and Woodworker," "Scientific American Supplement," "Canadian Mechanics' Magazine," "Carpentry and Building," "California Architect," "National Builder," "Illustrated Carpenter and

Builder" (English), "The Carpenter," and 'The Building World," and one or two other journals.

Many of the items taken from the foregoing have been changed, corrected and simplified, and put in such a shape that the ordinary workman will find but little difficulty in grasping them to such an extent as to render them useful.

In presenting a work of this kind to the public the author feels that he is making a somewhat hazardous venture, as he must naturally go over a great deal of ground that has been trodden by others, and it may be thought by many that a good portion of the matter put forth is a work of supererogation. It must be remembered, however, that a new generation "that knew not Joseph," crops up every few years, and it is for these, and for future generations that this work is compiled and written, while it contains much that is new and much that will be acceptable to active men now engaged in the building arts.

The author begs it to be understood that no literary merit is claimed for this work. Practical works offer but little opportunity for literary culture. To be exact, practical, clear and concise is perhaps the best that can be expected in a book of this kind, and, if I succeed on these

grounds and have so couched my language that the ordinary practical mind of the working man can thoroughly understand what I have meant to convey, I shall be well satisfied. So far as the financial success of the work is concerned past experience on these lines assures me of favorable results, and for this I am pleased for the publishers' sake, as they have advised me to "spare no expense" in making this book a "standard" for all time. Whether my humble abilities are equal to the task will be for the public to say. However, be this as it may, if the work fails of being what it is intended it will not be because of any parsimony on the publishers' behalf, but rather because of the inability of the author and compiler.

FRED T. HODGSON.

PREFACE TO SECOND EDITION.

VOLUME I.

It is now more than six years since the first edition of this work was published, and during that time the author and publisher have received thousands of inquiries and requests regarding an extension and enlargement of the work, and because of these, and because of a desire to keep this and the second volume of the work up to date and abreast with modern requirements, we feel the time has arrived when new additional matter, problems, diagrams, and explanations are become necessary. To accomplish this, we have introduced in this edition, many new "Steel Square Kinks," and remodeled some of the previous work, and added a new feature in the shape of some very interesting problems in handrail construction, which we are sure will prove instructive reading matter, and will make this treatise on "The Steel Square and Its Uses," an exhaustive Cyclopedia of everything worth knowing in connection with this magical tool.

The hundreds of thousands of copies of the first edition of this work that are now in the hands of workmen and others, will not have their value impaired one whit, because of this new edition being placed on the market, as it will not detract from the usefulness of the first edition, and the new matter embodied in the present edition may be obtained at any time if considered necessary.

If the present edition meets with anything like the same favor the earlier edition enjoyed, both author and publisher will feel these have been made in the right direction.

FRED. T. HODGSON.

THE STEEL SQUARE

INTRODUCTION

While it is not intended to give a history of the steel square as far as known, it may not be amiss to say a few words regarding the origin of this useful tool. It is quite evident that many of the prehistoric races understood the use of a square of some kind, for in many of the old buildings and monuments that have come down to us from the time before writing was known, evidences of material having been "squared" are as numerous as the old ruins themselves. It is on record that a whole "kit" of carpenters' tools, with a square included, was found in an Egyptian tomb, dating four or five thousand years before Christ. This is a hoary antiquity, and disposes of the claim made by the Greeks that the tool was the invention of one Theodosius, a Greek, of Samos. Theodosius evidently was a mechanic and artist of some note, and may have improved the square, but he certainly never invented it. The steel square, however, as we know it, is of comparatively modern growth. The predecessor of the present

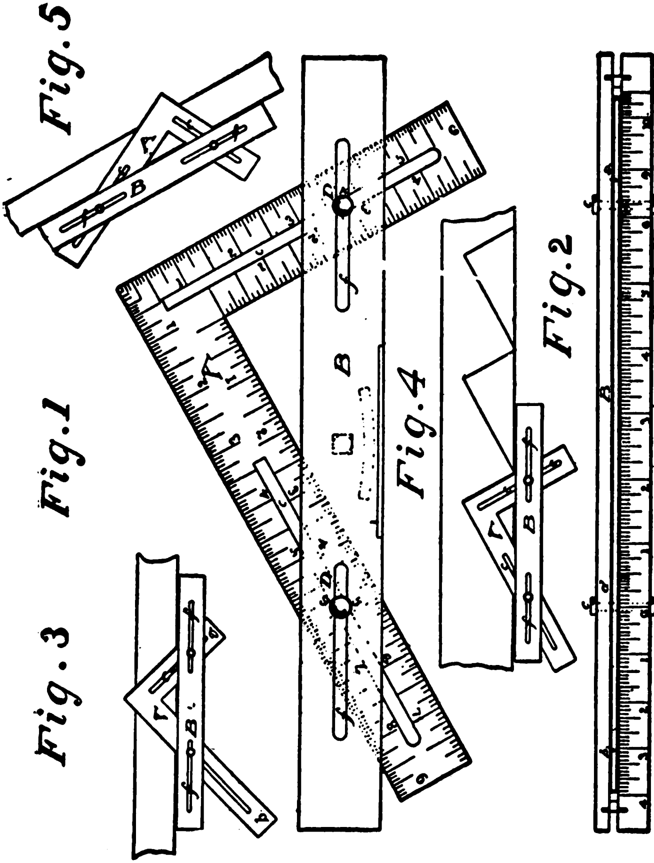
square was a clumsy iron tool, with a blade about 1½ inches wide, and a tongue about 1 inch wide. I say "about" because the squares were not by any means exact in their dimensions, or in their "truthfulness," and were not made use of by mechanics doing fine work, but were chiefly confined to blacksmith shops and similar places. Their marking and figuring were irregular and often incorrect and unreliable. These squares were mostly made in England, though I have seen a few that were manufactured in Belgium or France.

The first squares manufactured from steel and made with a 2-inch blade and 1½-inch tongue, so far as I have been able to discover, were made early in the nineteenth century near New Haven, Conn. These, however, were very crude affairs and not well figured. I have been told that steel squares, with a blade 2 feet long and 2 inches wide and tongue 1 foot 6 inches long and 1½ inches wide, were made in Sheffield one hundred and fifty years ago, and that some of these squares are still in existence, though I have not seen one nor have I any reliable evidence that such squares exist or ever did exist. Coming down to our own day, however, we are now well supplied with steel squares of fine quality

and perfect and accurate make. Indeed, there are "squares and squares," some of them being paragons of simplicity, while others are as wonderfully and fearfully made as the human structure, yet all of them possess some quality or qualities that justify their manufacture and insure a profitable return to the makers thereof.

Before entering into the more serious part of the subject under consideration I purpose giving a description of a number of squares that are now in the market, along with the manufacturer's directions for their use, and further, I also intend to illustrate and describe some of the charts, diagrams, keys and rules that have lately been devised, for the purpose of assisting the student in understanding the application of the square for the solving of roof and other problems.

The illustration shown at Fig. 1 represents a square and its attachments in elevation, of a recent invention, and Fig. 2 gives a view of its edge. A is a carpenter's square made of metal in the ordinary form with the outer edges graduated in inches and sixteenths, and the inner edges in inches and twelfths. The straight edge or stock, B, is in two parts, one upon each side of the square as shown in Fig. 2. These two parts



A Combination Square

of the stock are drawn together—grasping the square—by means of the bolts CC, which are provided with nuts D, having milled heads; dowell pins, *ee*, keep the parts in position. The bolts, CC, pass through long slots, *cc*, in the square, and *ff* in the stock, allowing the relative position of those two pieces to be varied.

The outer edge of the stock is graduated in inches as shown in Fig. 2, the inches from 0 to 6 inclusive being subdivided into twelfths, and at each side of these points into sixteenths.

It would be impossible to give directions for the use of this implement in the great number of cases in which it may be employed, but a few of the more important will be sufficient to suggest the others as occasions arise. If it is desired to obtain the length of a rafter for a roof of which the span is 32 feet and the perpendicular height is 16 feet, let one-fourth of an inch on the scale represent a foot in the roof; set the short arm of the square with the fourth inch—equal to 16 quarters of an inch for the 16 feet perpendicular height—even with the stock, and bring the fourth division on the long arm of the square—equal to 16 feet, one-half of the span—even with zero on the stock, then will the space on the stock between the two arms of

the square represent the length of the rafters, and this space may be read off on the scale of the stock where this scale is cut by the short arm of the square.

When the implement is thus adjusted to determine the length of a rafter the shorter arm, *a*, will give the bevel for the upper end, and the longer arm, *b*, of the foot, as shown in Fig. 5.

Fig. 3 illustrates the mode of adjusting tne implement to be used as a miter, and Fig. 4 shows the manner in which it may be used for laying out stairs; one limb giving the angle for the treads and the other for the risers.

This is called a "pitch-square," being especially designed for laying out roofs.

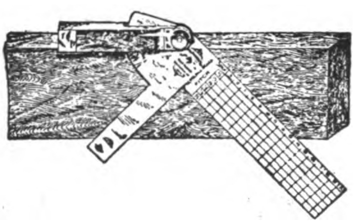


FIG. 6. TOPP'S FRAMING SQUARE

The "Topp's Framing Tool," Fig. 6, is another very curious and very ingenious square, and is intended as a sort of "ready-reckoner," as it contains on its blades rules for laying off nearly every kind of rafter, hip, valley and jack. The illustration shown gives some idea as to the style of square. It is claimed by the inventor, Mr. G.

A. Topp, of Indianapolis, "to be a great time saver, as no figuring is required for finding the lengths or bevels of rafters, and it enables the ordinary workman to frame roofs speedily and with absolute certainty." I have examined this tool and found it to be just as represented.

Another square—or rather combination tool—which was recently patented, is shown at Fig. 7. While I have not seen the tool itself, but judging from its appearance as shown in the illustration, I should imagine it to be much more ornamental than useful, and not grading high in either. Combination tools of this sort, while well enough for amateurs, generally cut a poor figure in the hands of expert workmen. I reproduce the claims made by the inventor of this tool so that the reader may have some idea of its capacity.

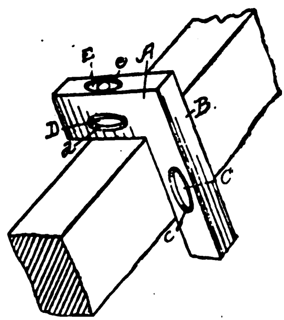


FIG. 7. COMBINATION SQUARE AND LEVEL

1. "A level frame having the members A and B of equal thickness, rigidly joined at right angles to each other and provided with lateral openings CD through one side of said frame, one of said openings being formed in last of

said members, and the edge opening *e* formed in the edge of said frame perpendicular to said side, in combination with leveling glasses inclosed longitudinally in said members and exposed through said openings, substantially as set forth.

2. "The described level, square and plumb, comprising the integral members A and B at right angles to each other, formed with longitudinal perforations and with surface openings thereto, in combination with the leveling glasses C, D and E in said perforations, two of said glasses lying parallel in the head A, and the other being perpendicular thereto in the blade B, substantially as set forth."

There are several other combination squares on the market, one known as the "Van Namee Framing Square," which possesses considerable merit,—but I fear it would be taking up too much space and making too great an inroad into the readers' time to describe more of them.


We now take up a square void of any attachments, and one which has become quite popular in the west and the middle southern states. I refer to the "Nicholls Square," a representation of one side of which is shown at Fig. 8. This square is a new one on the market, and presents some advantages over many now being sold. The manufacturers direct special attention to the fact that the board measure has been replaced by a simple rule for framing, and that there is to be found the lengths and figures giving the cuts for an entire roof, also the cuts for cornice of the same. The tongue on the square is 1¾ inches wide, thus making it convenient for spacing, as much of the dimension lumber is 1¾ inches thick. The general directions for using this square—a copy of which is given to every purchaser of a square—are pre-

Fig. 8

sented herewith, so that the reader will be able himself to judge of the merits of the tool. These squares are numbered or graded according to the graduation marks and quality of finish.

"The face of a square is the side on which we stamp our name. The reverse is the back. The longer arm is the body, the other is the tongue.

Framing Rule.—The first line of figures gives the length of common rafters for one foot run.

The second line of figures gives the length of hip or valley rafters for one foot run.

The third line of figures gives the length of first jack rafter and the difference in the length of the others spaced 16 inches on centers.

The fourth line of figures gives the length of first jack rafters and the difference in the length of the others spaced 2 feet on centers.

The fifth line of figures gives the side cut of jack rafters against hip or valley rafters.

The sixth line of figures gives the side cut of hip or valley rafter against ridge board or deck.

The seventh line of figures gives the cuts of sheathing and shingles in valley or hip, for example:

1. If your roof is raised 8 inches to the foot, or, as it is called, third pitch, under 8 on the first line are the figures 14.42. This is the length of

common rafters for one foot run. If the building is 16 feet wide half the width of building would be the run of common rafter. In this case it would be 8; multiply 14.42 by 8, you have 115.36 inches, or 9 feet 7¾ inches.

2. To obtain the bottom and top cuts of common rafter use the figures 12 on body and 8 on tongue; 12 side gives bottom cut, 8 side gives top cut; the same figures give bottom and top cuts for jack.

On the second line under 8 are the figures 18.78; multiply these figures by 8, which is the run of the common rafter. This gives 150.24, or 12 feet 6¼ inches. This is the correct length of hip or valley rafter. To obtain the bottom and top cuts for hip or valley rafters, use the figures 17 on body and 8 on tongue; 17 side gives bottom cut, 8 side gives top cut.

This is all the figuring necessary to be done. The reason for giving the lengths for one foot of common and hip or valley rafters is that it will work in all cases regardless of width of buildings.

3. On the third line under 8 are the figures 19¼ inches. This is the length of first jack rafter, also the difference in the length of the others spaced 16 inches on centers. For example, the

first jack being 19¼ inches, the second jack would be 3 feet 2½ inches; make each one 19¼ inches longer than the other.

On the fourth line under 8 are the figures 2 feet 4⅞ inches. This is the length of the first jack rafter, and the difference in the length of the others spaced 2 feet centers.

On the fifth line under 8 are the figures 10 and 12. By placing square on stock to be cut at these figures 10 on body, 12 on tongue, and marking on 12 side this gives side cut of jacks against hip or valley rafter.

On the sixth line under 8 are the figures 9 and 10. By placing square on stock to be cut at these figures, 9 on body and 10 on tongue, and marking on the 10 side, this gives side cut of hip or valley rafter against ridge board or deck.

On the seventh line under 8 are figures 12 and 10. By placing square on stock to be cut at these figures 12 on body, 10 on tongue, and marking on the 10 side this gives the cut of sheathing and shingles in valley or hip.

Remarks.—To obtain the lengths and cuts be careful to use the figures under whatever figure your roof raises to the foot. If your roof raises 12 inches to the foot, or half pitch, look under 12, and so on in all cases. In cutting jack

rafters allow for half the thickness of hip or valley rafters as lengths given on square are to center lines.

Note.—The figures on the square, giving side cuts of jacks, will also give the correct miter cuts for moulding in the valley at the junction of two gables, also miter cuts for gable mouldings where it intersects with level mouldings at the end of building.

The figures giving cuts of sheathing in valley or hip also give cuts for mitering level plancier with gable plancier, also the miter cuts where two gable planciers intersect, also the cut for plancier on gable end.

To obtain the bottom and top cuts of hip or valley rafter use the figure 17 on body, and whatever figure your roof raises to the foot on tongue. This will give you the correct cuts in all cases.

To obtain the bottom and top cuts of common rafters and jack rafters use the figure 12 on body, and whatever figure your roof raises to the foot on tongue. This gives correct cuts in all cases. Always remember that the cut comes on the tongue, or last named figure. It is so arranged in all cases.

Octagon, "Eight-square" Scale.—This scale is

along the middle of the face of the tongue, and is used for laying off lines to cut an "eight square" or octagon stick of timber from a square.

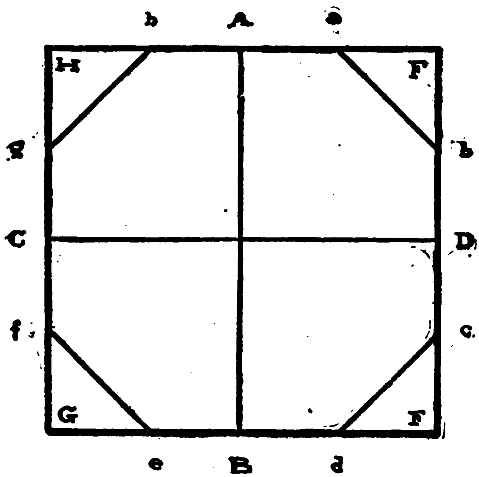


FIG. 9. OCTAGON SCALE

Suppose the figures A, B, C, D, Fig. 9, is the butt of a square stick of timber 6x6 inches. Through the center draw the lines AB and CD parallel with the sides and at right angles to each other.

With the dividers take as many spaces (6) from the scale as there are inches in the width of the stick, and lay off this space on either side of the point A as Aa and Ab; lay off in the same way the space from the point B as Bd and Be;

also Cf and Cg and Db and De. Then draw the lines ab, ed, ef and gh. Cut off the solid angle E, also F, G and H; there is left an octagon, or "eight square" stick. This is nearly exact.

Brace Measure.—This is along the center of the back of the "tongue," and gives the length of the common brace.

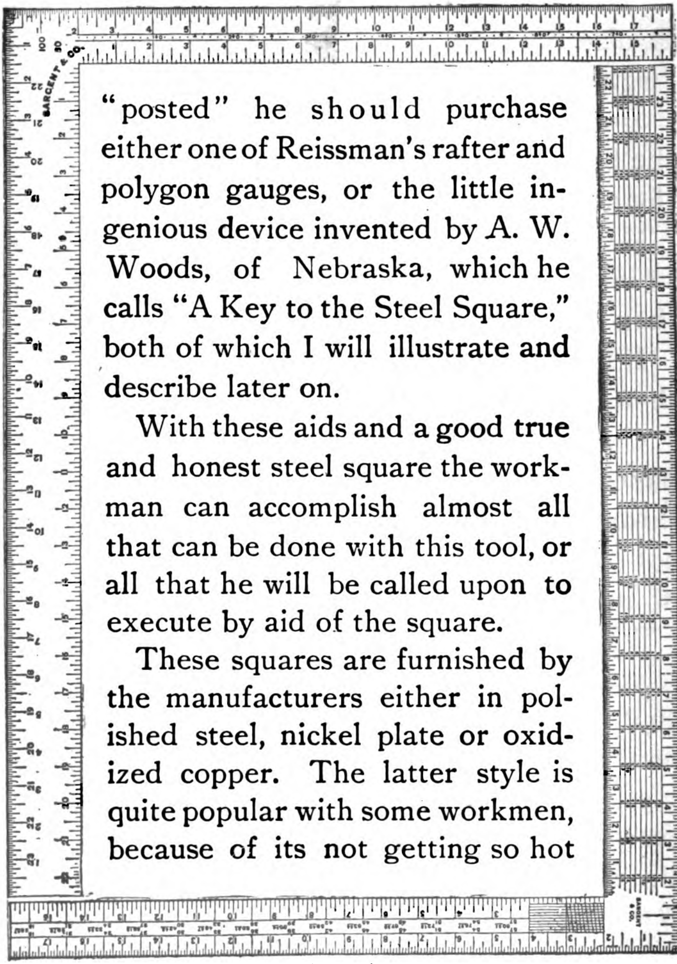
$\frac{18}{18}$ 25.45 in the scale means that if the run is 18 inches on the post and the same on the beam, then the brace will be $25\frac{45}{100}$ inches.

If the run is 21 inches on both beam and post, then the brace will be $29\frac{70}{100}$ inches.

Care of Square.—Never use emery or sand paper on nickel or black finished squares. When through using put on a few drops of oil. Do not put your square away with finger marks on it; nothing rusts it so quickly as perspiration."

It will be seen that these squares adapt themselves to other work as well as to framing, a quality very few of the combination squares possess, and while combination squares have their special uses and should be in the tool chest of every expert workman, the square pure and simple, like this of Nicholls or similar ones, should never be absent from the "kit" of the ordinary workman, for with it, if he thoroughly understands it, he can accomplish all that is possible

even with a combination square. If he is not



"posted" he should purchase either one of Reissman's rafter and polygon gauges, or the little ingenious device invented by A. W. Woods, of Nebraska, which he calls "A Key to the Steel Square," both of which I will illustrate and describe later on.

With these aids and a good true and honest steel square the workman can accomplish almost all that can be done with this tool, or all that he will be called upon to execute by aid of the square.

These squares are furnished by the manufacturers either in polished steel, nickel plate or oxidized copper. The latter style is quite popular with some workmen, because of its not getting so hot

FIG. A

when exposed to the rays of the sun.

The two sides of the square, shown at Fig. A, represent the carpenters' popular square, No. 100. This square has been a special favorite with workmen for nearly thirty years, and is still looked upon by many as being the *ne plus ultra* of steel squares. I show both sides of the square in order to enable the workman to see, before he buys, the kind of tool he will get. Like the Nicholls square, this may be obtained in polished steel, nickel plated, or oxidized copper as the purchaser may desire.

I show the complete square, reduced to page size. Sometimes this square is catalogued by dealers as No. 1000, practically, however, it is the same square as the No. 100. If we examine this square we will find on the tongue near its junction with the blade a series of lines and cross lines (see Fig. 10), making a figure known as the "diagonal scale." This scale is drawn to a larger size at Fig. 10*a*, and is shown alone and is used for taking off the

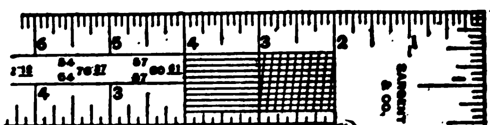
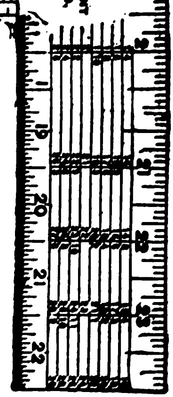



FIG. 10. SHOWING DIAGONAL SCALE

hundredths of an inch. The line *ab* is here an inch long, and is divided into ten equal parts; the line *cd* being also divided into ten equal parts, and diagonal lines are then drawn connecting the points as shown in the diagram. Suppose we wish to take off $\frac{76}{100}$ of an inch, we proceed as follows: Count off seven spaces from *c*, *e*, *g*, which equals $\frac{70}{100}$ of an inch; then count up the diagonal line until the sixth horizontal line, *e*, is reached, when *e f* will equal the required distance of $\frac{76}{100}$ of an inch, which is a trifle over ¾ of an inch.

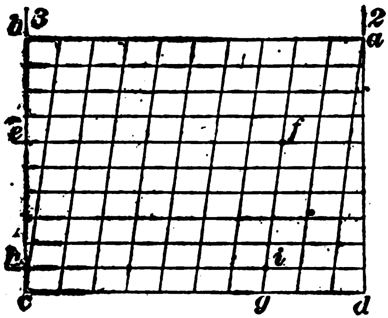


FIG 10*a* ENLARGED DIAGONAL SCALE

Quoting from the table of directions given in Sargent's circular describing this square, we have, for rafter cuts, the following explanation: "The run of a rafter set up in place is the horizontal measure from the extreme end of the foot to a plumb-line from the ridge end—from A to B, Fig. 11.

"The rise is the distance from the top of the ridge end of the rafter to the level of the foot. From C to D, Fig. 12.

"The pitch is the proportion that the rise

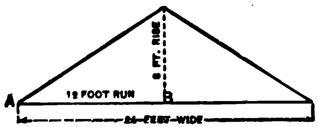


FIG. 11. SHOWING RAFTER RUN

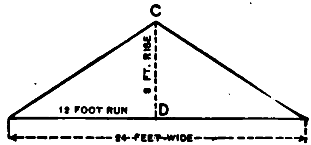


FIG. 12. SHOWING RAFTER RISE

bears to the whole width of the building. The illustration, Fig. 13, shows one-third pitch; the rise of 8 feet being one-third of the width of the building.

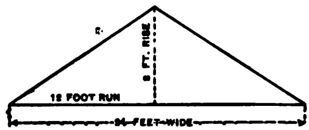


FIG. 13. SHOWING ROOF PITCH

"The cuts or angles of a rafter are obtained by applying the square so that the 12-inch mark on the body and the mark on the tongue that represent the rise shall both be at the edge of the rafter. The illustration, Fig. 14, shows 8 foot rise, the line A the cut for the ridge end of the rafter and B the cut for foot end."

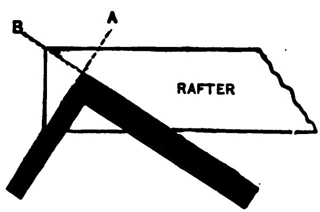


FIG. 14. SHOWING METHOD OF OBTAINING CUTS AND BENDS

The portion of square shown at Fig. 15 exhibits the tool having on its face a table of the run, rise and pitch of rafters, being specially figured for this purpose, and shows the measure

of the rafter for any one of seven pitches of roof

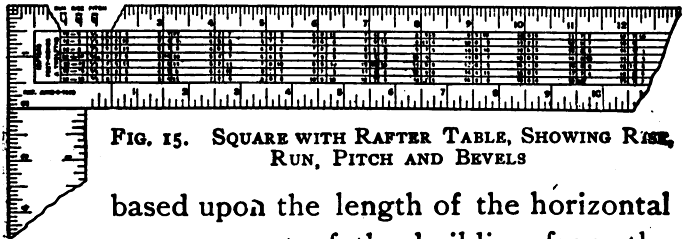


FIG. 15. SQUARE WITH RAFTER TABLE, SHOWING RISE, RUN, PITCH AND BEVELS

based upon the length of the horizontal measurement of the building from the center to the outside.

The following table, which was prepared especially for this square, shows the manner of working the square:

RAFTER TABLE DIRECTIONS

The rafter table and the outside edge of the back of the square, both on body and tongue, are in twelfths. The inch marks may represent inches or feet, and the twelfth marks may represent twelfths of an inch or twelfths of a foot (that is, inches) as a scale. The rafter table is used in connection with the marks and figures on the outside edge of the square.

At the left end of the table are figures representing the *run*, the *rise* and the *pitch*.

In the first column the figures are all 12, which may be used as 12 inches or 12 feet, and they represent a *run* of 12.

The second column of figures is to represent various *rises.*

The third column of figures in fractions represents the various *pitches.*

These three columns of figures show that a rafter

with a run of 12 and a rise of 4 has 1/6 pitch,

with a run of 12 and a rise of 6 has 1/4 pitch,

with a run of 12 and a rise of 8 has 1/3 pitch,

and so on to the bottom of the figures.

To Find the Length of a Rafter.—For a roof with 1/6 pitch (or the rise 1/6 the width of the building) and having a run of 12 feet, follow in the rafter table the upper 1/6 pitch ruling, find under the graduation figure 12 the rafter length required, which is 12 7 10, or 12 feet and $7\frac{10}{12}$ inches.

For 1/2 pitch (or the rise 1/2 the width of the building) and run 12 feet, the rafter length is 16 11 8, or 16 feet $11\frac{8}{12}$ inches.

If the run is 25 feet, add the rafter length for run of 23 feet to the rafter length for run of 2 feet.

When the run is in inches, then in the rafter table read inches and twelfths instead of feet and inches. For instance:

If with 1/2 pitch the run is 12 feet 4 inches, add

the rafter length of 12 feet to that of 4 inches, as follows:

For run of 12 feet the rafter
length is . . . . 16 feet 11$\frac{8}{12}$ inches.
For run of 4 inches the rafter
length is . . . . 5$\frac{8}{12}$ inches.
Total . . . . 17 feet 5$\frac{4}{12}$ inches.

The brace measure on these squares is along the center of the back of the tongue, and gives the length of the common braces as shown in Fig. 16. Examples are shown in the blade as at the point marked 24 30, which means 24 inches on the post and 18 inches on the beam or girt, which make the brace 30 inches long from point to point according to the rule given.

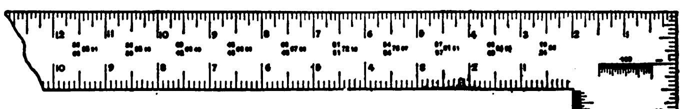
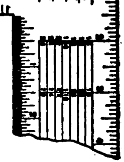



FIG. 16. SHOWING BRACE RULE

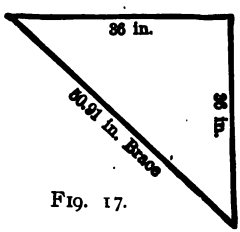


FIG. 17.

An application of this rule is shown at Fig. 17, where 36 inches are laid off on both post and beam, which gives the length of the brace from point to point 50.91 inches, or very nearly 4 feet 3 inches. Other dimensions are

shown in the square. There is also a scale of one-hundredths, or one inch divided into 100 equal parts.

The octagon scale on this square runs along the middle of the face of the tongue, and is used for laying off lines to cut an "eight square" or octagon stick of timber from a square one.

Suppose the figure ABCD (see Fig. 9) is the butt of a square stick of timber 6x6 inches. Through the center draw the lines AB and CD parallel with the sides and at right angles to each other. With a pair of compasses take as many spaces (6) from the scale as there are inches in the width of the stick, and lay off this space on either side of the point A, as Aa and Ab; lay off in the same way the same space from the point B as Bd, Be; also Cf, Cg and Db, Dc. Then draw lines ab, cd, ef and gh. Cut off the solid angle E, also F, G and H. This will leave an octagon, or eight-sided stick, which will be found nearly exact on all sides.

The board measure, known as the "Essex Board Measure," Fig. 17½ is made use of in figuring these squares, and is used as follows: Figures 12 and 17 in the graduation marks on the outer edge represent a one-inch board 12 inches wide, which is the starting point for all calculations.

The smaller figures under the 12 represent the length.

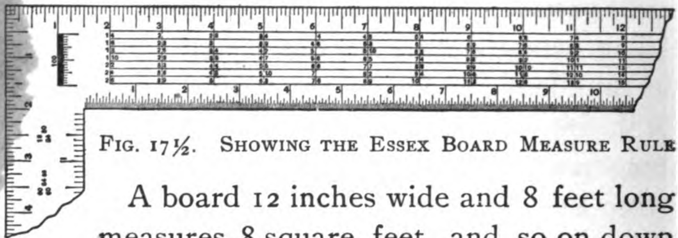


Fig. 17½. Showing the Essex Board Measure Rule

A board 12 inches wide and 8 feet long measures 8 square feet, and so on down the table. Therefore, to get the square feet of a board 8 feet long and 6 inches wide, find the figure 8 in the scale under the 12-inch graduation mark and pass the pencil along to the left on the same line to a point below the graduation mark 6 (representing the width of the board), and you stop on the scale at 4, which is 4 feet, the board measure required. If the board is the same length and 10 inches wide, look under the graduation mark 10 on a line with the figure 8 before mentioned, and you will find $6\frac{8}{12}$ feet board measure; if 18 inches wide then to the right under the graduation mark 18, and 12 feet is found to be the board measure. If 13 feet long and 7 inches wide, find 13 in the scale under the 12-inch graduation and on the same line under the 7-inch graduation will be found $7\frac{7}{12}$ feet board measure. If the board

is half this length, take half of this result; if double this length, then double this result. For stuff 2 inches thick double the figures.

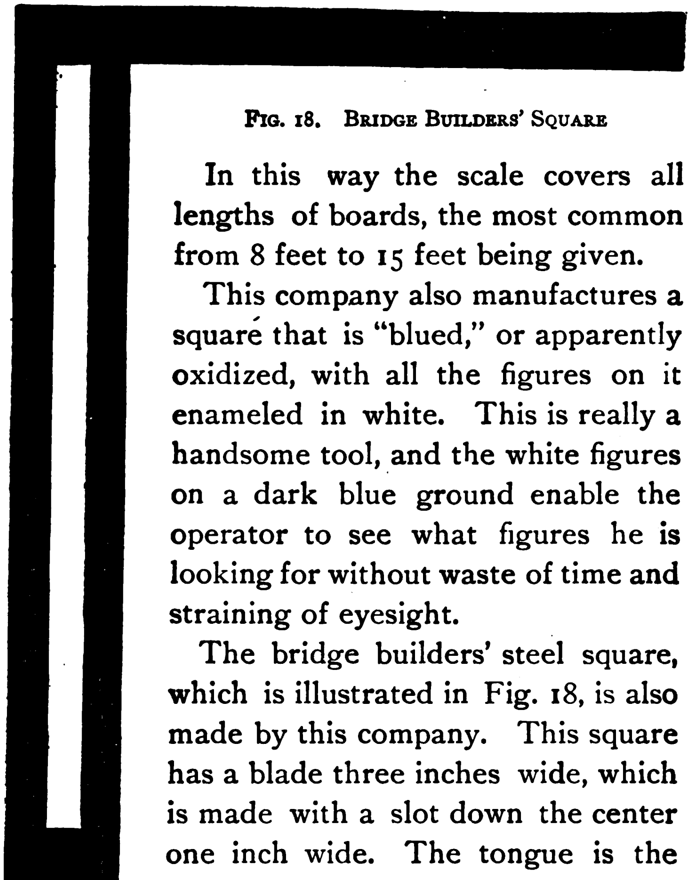


FIG. 18. BRIDGE BUILDERS' SQUARE

In this way the scale covers all lengths of boards, the most common from 8 feet to 15 feet being given.

This company also manufactures a square that is "blued," or apparently oxidized, with all the figures on it enameled in white. This is really a handsome tool, and the white figures on a dark blue ground enable the operator to see what figures he is looking for without waste of time and straining of eyesight.

The bridge builders' steel square, which is illustrated in Fig. 18, is also made by this company. This square has a blade three inches wide, which is made with a slot down the center one inch wide. The tongue is the same as in the No. 100 square, but has no figures for brace or octagon rules. It is

not so handy for general purposes as the regular square, but for special purposes in bridge building, or for laying out very heavy timber structures it has special advantages, as 3-inch shoulders and 3-inch tenons and mortises can be readily laid out with it. Another square, shown in Fig. 19, known as the "machinists' square," is made by this company. It has a blade 6 inches, and a tongue 4 inches long, and is very finely finished. This square is found very useful for pattern makers, piano and organ builders, and where other especially close work is required. A number of other squares are made by this firm, but as they are not intended for woodworkers' use I will not describe them here.

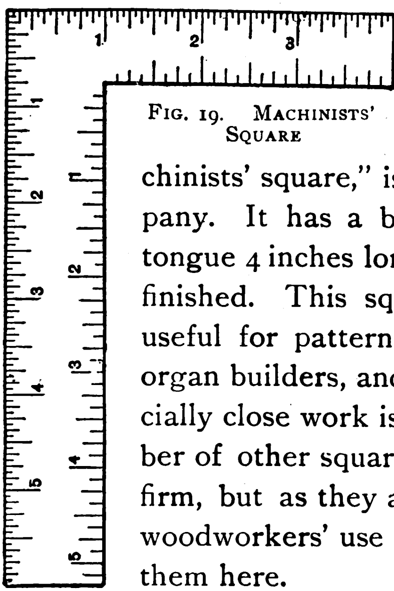


FIG. 19. MACHINISTS' SQUARE

I would not complete this description of Sargent's make of squares if I failed to make mention of their "bench square." I give this name to it because of its fitness for bench purposes. The square referred to has a blade 12 inches long and 1½ inches wide, and a tongue 9 inches long and 1 inch wide. The figuring on

it is divided into inches, half inches, quarter inches, eighths and sixteenths of an inch. This is a very handy square for bench and jobbing purposes, and can be used in many places where the larger tool is unavailable, and may on emergency be employed for laying out rafters, braces and similar work.

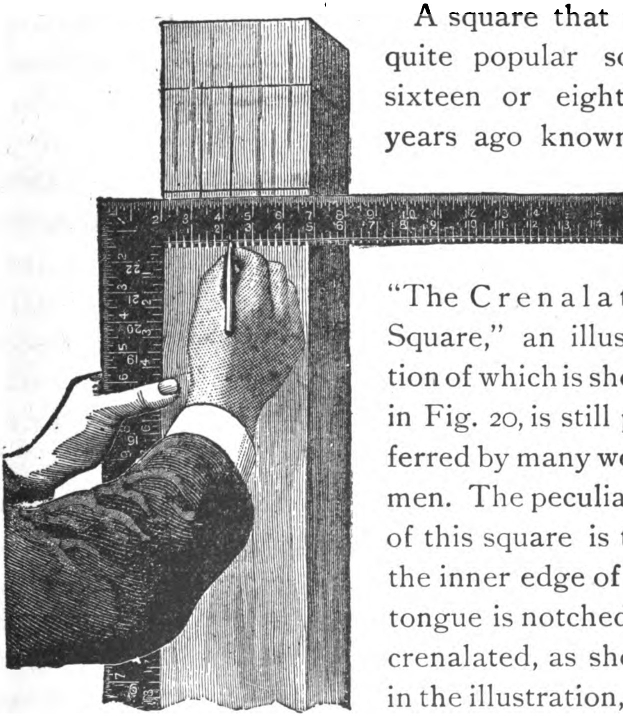


FIG. 20. CRENALATED SQUARE

A square that was quite popular some sixteen or eighteen years ago known as "The Crenalated Square," an illustration of which is shown in Fig. 20, is still preferred by many workmen. The peculiarity of this square is that the inner edge of the tongue is notched, or crenalated, as shown in the illustration, the notches being intended as "gauge-points," where a sharpened pen-

cil may be inserted, then the square may be drawn along the timber or board, with the blade held snug against the edge, as shown, and mortises or tenons can be laid out at will.

Besides being crenalated, these squares have all the advantages of other squares, and are well made and pleasant to handle. They are made by the manufacturers, The Peck, Stowe & Wilcox Co., of Southington, Conn., in polished steel, copper plated, blued, with enameled white figures, and in nickel plate.

Another combination tool, consisting of slotted square and rules, is shown in Fig. 21. I give the

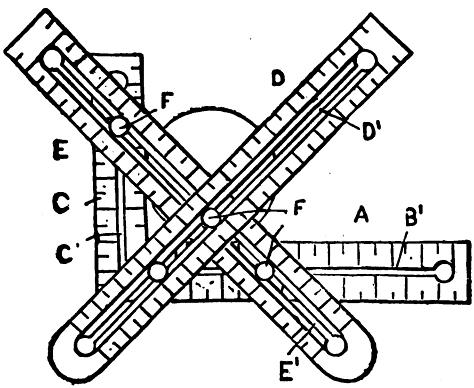


Fig. 21. Square Set for Miters

inventor's description of it, and upon examination I have found that with a little study the tool is capable of performing all that is claimed for

it. While I do not recommend this tool as being the best suited to the carpenter's requirements, it may prove a great help to him in solving many problems. Here is what the inventor says: "The invention consists mainly of a square and two slotted straight edges adapted to be fastened upon it by means of bolts. The great utility of this improved instrument will at once be appreciated in the hands of the practical mechanic. The steel square is not like such other mechanical tools as the hammer, saw or plane, which bring into use the strength and motion of the arm. The square on the other hand brings into use the powers of the mind. The carpenter of to-day is an intelligent mechanic, and he requires tools which are up to the times and fully adapted to the work in hand. This tool does not fail to meet with the approval of all who have seen it, and those who use it in their respective trades.

"The instrument enables the mechanic to ascertain the lengths and bevels of all diagonal lines by an improved and ready method without the use of mathematical calculation, such as the lengths and bevels of all kinds of rafters, hips, groins, braces, brackets, purlines, collar-beams and jack rafters, also the bevels and cuts for

hoppers and all the straight lines required in stair-building and handrailing, and the bevels and cuts for polygon miters of any number of sides up to 12.

"With this instrument the carpenter can also measure the width of streams for bridge work, height of buildings, trees or mountains.

"The square can be operated with one rule or two rules, or on squares that are not slotted, by the use of a washer of the same width or diameter as the rule being placed on the opposite side to that of the rule.

"A model of the above instrument may be had, consisting of one square 6x4, rules 1x8, and protractor 2x5, with scales and rules, etc., made from fine white strong cardboard. All the lines are printed with black ink. More knowledge can be derived in one hour by the use of this model than by reading books and drawings for a week."

There was published in connection with this square a little book of directions in which the manner of working the square for the solution of various problems was fully described, but I do not think, in view of the fact that later on I will endeavor to illustrate many of the same problems and solutions, that it is necessary to say

more of this combination tool than to state that

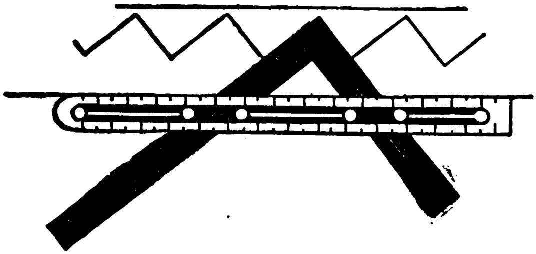


FIG. 22. SET FOR STAIR STRING

Fig. 21 shows the instrument set for miters Fig. 22 for laying out treads and risers for stairs, and Fig. 23 is arranged for laying out equal spaces either for joists, studding, rafters or any other work requiring equal spacing. The spaces may be any distance within the capacity of the length of the slot in the blade and the projecting edges of the rules.

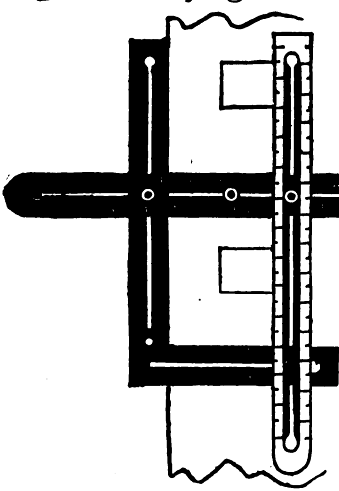


FIG. 23. SET FOR SPACING GAINS

Another class of steel squares which carpenters and joiners and stair-builders are using to some extent may now be discussed.

The illustration shown at Fig. 24 exhibits two steel try-squares that are adjustable. They are also graduated so that the stock can be set to

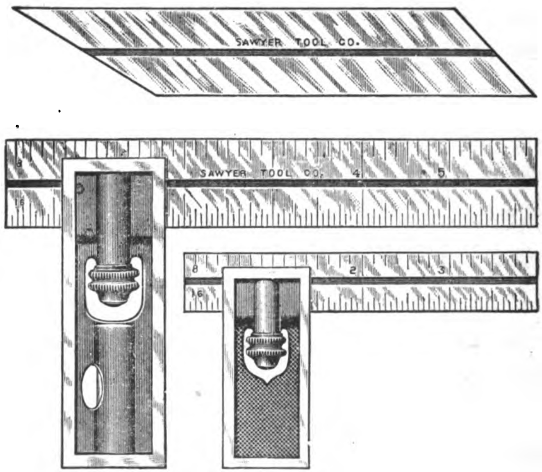


FIG. 24. ADJUSTABLE TRY STEEL SQUARE

any distance within the limits of the squares, this adjustment being regulated by the loosening of the thumb screw when the stock can be moved along the slot to any desired point and held there by simply tightening the thumb screw. This makes a very handy try-square for bench purposes when getting out dimension stuff by hand for fine work, the divisional lines being fine and accurate.

In the stock of the larger squares there is a

spirit bulb accurately set, so that the square can, if desired, be used as a level or for a plumb. These squares are supplied with hardened blades. The larger size with the level will often be found convenient. A hardened bevel blade with ends ground to angles of 30° and 45° is furnished when desired. This can be inserted in the mortise made in the stock to receive the blades, which, of course, must be removed to make room for the beveled blade.

These tools are manufactured by the Sawyer Tool Manufacturing Company, Massachusetts, who also manufacture several other kinds of try-squares of a less costly quality. This firm also makes a steel square which the firm calls the "combination set," an illustration of which is

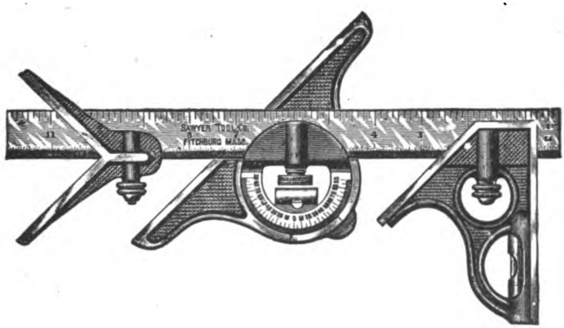


FIG. 25. COMBINATION SQUARE, MITER AND INCLINOMETER

shown at Fig. 25. This square has a blade 24 inches long, accurately divided in fine grades,

and has a slot running its whole length—not shown in the cut, as the reverse side confronts us—in which the attachments slide. These attachments are held in place by thumb screws, two of them having spirit bulbs in them, so that the square may be used as plumb rule, level or inclinometer, as the attachment shown in the middle of the square, may be placed at any angle as a protractor, on which all the degrees from 1 to 180 are carefully marked. This tool, with its attachments, may be used for a great many purposes in framing and general work. The square stock has a miter angle on its back edge which will be found handy for laying off miters on mouldings when there is not a miter-box in sight. It will be found very useful in cutting trim where the stuff is beaded or moulded on the edge. The central attachment forms a bevel stock, as it can be set to any bevel, and the blade may become the blade of a bevel by simply loosening the set-screw, adjusting the angle and then tightening up again. The third attachment is simply a right angle with its two sides set at angles of 45° to the edges of the blade. The skilled workman will understand the use of this at a glance, as its application to cutting double miters will suggest itself imme-

diately. Any or all these attachments can be slid off the blade instantly, which gives a fine and correct straight edge and measuring rule. Left with the stock alone it becomes an ordinary try-square or a long miter tool, just as the workman may decide.

These tools are made of the very best materials and the workmanship is, like Caesar's wife, "above suspicion." In the square in my possession the spirit bulbs are placed in position with the greatest of care, the adjustments being as near perfect as possible, and the protractor, under test, is all that can be desired.

Another series of squares made on similar lines, possessing the same qualifications, workmanship and materials, is manufactured by the L. S. Starrett Company, Massachusetts, a firm known the world over for the excellence and

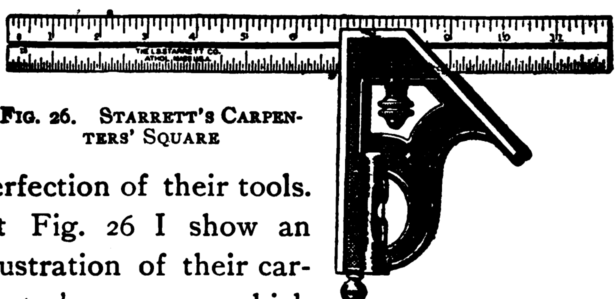


FIG. 26. STARRETT'S CARPENTERS' SQUARE

perfection of their tools. At Fig. 26 I show an illustration of their carpenter's square, which has a movable stock, and may be had with

blades 24 inches long. The stock can be moved or "slid" along the blade to any point, and one side may be used as a square and the other as a miter at the will of the operator. The stock is held in place by the aid of a thumb screw, as seen, and, as the "tit" sliding in the slit is accurately fitted, it is next to impossible for the tool to get "out of truth." These squares are all tested before leaving the works. The stock is fitted up with a spirit level bulb, which is accurately adjusted and tested before being placed on the market. With this bulb the square may at a moment's notice be converted into a level or a plumb rule. The square may be obtained alone, as shown in the illustration, or it may be ordered with attachments, which include center head and bevel protractor or inclinometer, all of which may be added to, or removed from, in a very short time. The instrument, as shown in the illustration, is complete, but the attachments give it a much greater range.

This company also manufacture a square attachment which they call "Starrett's Stair Gauge Fixtures," of which I give an illustration at Fig. 27, which also shows a few of the applications of the device.

A pair of these fixtures can be readily clamped

to a carpenter's steel square to form a gauge for various uses.

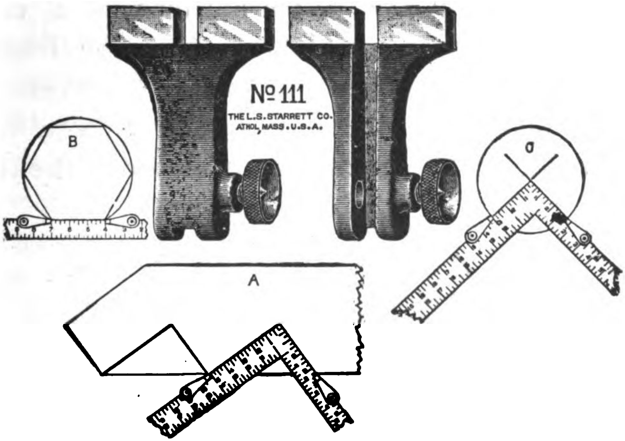


Fig. 27. Starrett's Stair Gauge

Sketch A shows the gauge as applied for laying out a stair stringer, sketch B laying off hexagon angles, sketch C as used as a center gauge or in quartering a circle.

As a matter of fact this device is intended to take the place of the old-time "fence," of which I will have more to say further on.

STEEL SQUARE TABLES AND RULES

We now enter into another phase of the subject, namely, a discussion of the various schemes and devices invented for the purpose of making the uses and applications of the steel

square easy to understand. One of the best of these is known as "The Key to the Steel Square," by A. W. Woods, which is a very ingenious device for showing how the length and bevels for all kinds of rafters, hips, valleys, jacks and braces may be obtained in a few moments. The instrument is shown in the two

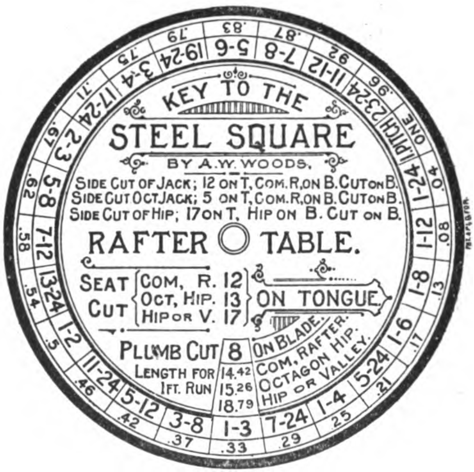


FIG. 28. STEEL SQUARE KEY

cuts, Figs. 28 and 29, and the directions for using are given in the following:

KEY TO THE STEEL SQUARE

These directions are published in connection with the framing chart known by the above title. The chart consists of a dial plate 3½x3½ inches square, on either side of which is a revolving

disk, one side giving the lengths and cuts for the common rafter, having a rise from 1 to 24 inches to the foot, also the corresponding lengths and cuts, and bevels for the octagon hip or valley, and for the hip or valley resting on a right angled corner, while on the other side is given the seat and plumb cuts for rafters and braces having a rise from 1° to 90°. It also gives the length of sides and miter cuts for all

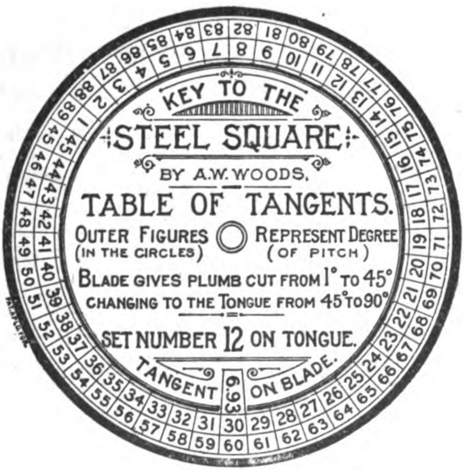


Fig. 29. Steel Square Key

regular polygons, or the framing of timbers at any degree, and shows how to apply the steel square to obtain the cuts.

EXPLANATION

The side containing the rafter table is divided

into twenty-four sections, radiating to a common center. These sections represent from 1 to 24 inches rise to the foot in run. The first figures represent the rise, and the three following sets of decimal numbers represent the lengths in inches of the common rafter, octagon hip and the common hip or valley rafter respectively. The heavy-faced fractional numbers designate the pitch or proportion of the rise of the roof to that of the span, while just beneath the fractional numbers is given the same value in decimal fractions to the one-hundredth part of an inch. The latter is placed here for convenience in finding the near equivalent in common fractions for the decimal part of an inch.

The revolving disk contains the title and abbreviated instructions. By turning the disk until the slot rests opposite the pitch desired only the lengths and cuts for that pitch will be exposed, thereby preventing errors.

EXAMPLE: TO FIND THE LENGTHS AND CUTS FOR THE ½ PITCH

Operation.—Turn the disk until the slot is opposite ⅓ and you have as follows: 12 on the tongue and 8 on the blade. The tongue will give the seat cut and the blade the plumb cut for the common rafter.

For the corresponding octagon hip and the common hip, or valley, substitute 13 and 17 on the tongue and blade respectively. (Neither are absolutely correct, though near enough for all practical purposes.) The tongue always giving the seat cut and the blade the plumb cut. The lengths of the rafters for a one-foot run are found to be 14.42, 15.26 and 18.76 for the common rafter, octagon hip and common hip, or valley, respectively. Having the lengths given from one foot in run it is an easy matter to find the lengths of the rafters for any run in either feet or inches by multiplying the lengths here given by the number of feet and fraction of a foot in the run, and point off as many places in the product as there are decimal figures used in the solution, and reduce to feet and inches. Fractional figures may be avoided in the run by dropping them and finding the length only for the number of feet, and then from the plumb cut measure square out the amount of the fraction, which will give the point for the proper plumb cut.

To find the common difference in the length of jacks multiply the length of the common rafter (14.42) by the number of inches in the spacing, and divide by 12. Thus, if the jacks be

placed 16" on centers, $14.42 \times 16 = 230.72 \div 12 = 19\frac{3}{12}$ + inches.

To find the common difference for the octagon jack multiply 14.42 by 2.4, and the product by the spacing, and divide by 12. Thus: $14.42 \times 2.4 = 34.608 \times 16 = 553.728 \div 12 = 46\frac{1}{12}$ + inches.

For the Side Cut of the Jack.—Take 12 on the tongue and 14.42 ($14\frac{5}{12}$) on the blade. The blade will give the desired cut.

For the Side Cut of the Octagon Jack.—Take 5 on the tongue (because 5 is practically equal to the side of an octagon when the diameter is one foot) and $14\frac{5}{12}$ on the blade, the blade giving the cut.

The figures that give the side cut of the jacks in either of the above cases will also give the cut across the face of the roof boards to fit in the valley or over the hip. The tongue gives the cut.

For the Side Cut of the Hip or Valley.—Take 17 on the tongue and 18.79 ($18\frac{19}{24}$) on the blade; the blade giving the cut.

Backing of the Hip.—Take 17 on the tongue and 8 on the blade. The tongue will give the required bevel. A quicker way, however, is to set off ½ the thickness of the hip along the line of the seat cut (or a line parallel with it), which

will give the gauge point from which to remove the wood to the center of the back of the hip. The backing for the octagon hip is practically one-half of that for a hip resting on a square corner.

REFERRING TO THE TABLE OF TANGENTS

The figures in the two circles represent the degree. Those in the inner circle represent the tangents, and those in the outer represent the cotangents, the sum of the two always equaling 90°.

The set number is in either case 12 on the tongue and tangents on the blade. The blade gives the plumb cut up to 45°, then it reverses to the tongue from 45° to 90°.

EXAMPLE: TO FRAME A ROOF WITH 30° PITCH

Operations.—Turn the slot till it rests opposite 30°.

Common Rafter.—Take 12 on the tongue and 6.93 ($6\frac{15}{16}$) on the blade.

Octagon Hip.—Take 13 on the tongue and $6\frac{15}{16}$ on the blade.

Hip or Valley.—Take 17 on the tongue and $6\frac{15}{16}$ on the blade. The tongue in either of the above cases gives the seat cut and the blade the plumb cut.

Side Cut of Jack.—Take 12 on the tongue and the diagonal length from 12 to $6\frac{15}{16}$ taken on the blade. The blade will give the cut.

Side Cut of Octagon Jack.—Take 5 on the tongue and proceed as for the common jack.

Side Cut of Hip or Valley.—Take 17 on the tongue and the length from 17 to $6\frac{15}{16}$ taken on the blade. The blade will give the cut.

If the roof be 60° pitch proceed the same as for the 30° pitch (using the same figures), but the cuts are reversed on the square. However, this only applies to the seat and plumb cuts.

EXAMPLE: TO FIND THE MITER FOR ANY REGULAR POLYGON

Operation.—Divide 180 by the number of sides in the polygon. The quotient will be the degree of the miter.

EXAMPLE: TO FIND THE MITER FOR A NONAGON (9 SIDES)

Operation.—$180 \div 9 = 20$. Turn the slot to 20° and we have 4.37. Then 12 on the tongue and 4.37 ($4\frac{3}{8}$) on the blade will give the miter, the blade giving the cut. 4.37 is also the length of the sides of the polygon when the inscribed diameter is one foot. If the diameter be 8 feet multiply $4.37 \times 8 = 34.96 \div 12 = 2'\ 10\frac{23}{24}''$. Therefore,

2' $10\frac{33}{64}''$ will be the length to cut the pieces. Only polygons with number of sides that will divide 180 without a remainder are contained in the table, the octagon and heptagon being in this number. Their tangents are 4.97 and 5.78, respectively.

EXAMPLE: TO FRAME TIMBERS AT ANY DEGREE OF PITCH

Frame two pieces at an angle of 110°. It is evident that the miter should stand at half way between the two pieces, or at 55°, and 55° from 90° leaves 35, and we find the tangent for 35° is .70021, which multiplied by 12 equals 8.40 ($8\frac{13}{32}''$). Therefore, 12 on the tongue and $8\frac{13}{32}''$ on the blade will give the miter, the blade giving the cut.

The reader will notice that the chart only applies to the even pitched roof, or in other words, where the several parts are of the same pitch; and while it may be used for the common rafter in such roofs, it does not apply in such cases to the hip and valley, or the length of their jacks. The side cuts for the jacks, however, may be found by taking the run of the left common rafter on the tongue and the length of the right common rafter on the blade. The blade will give the cut for the right jack; *vice versa* for the left jack.

The foregoing is copyrighted by Mr. Woods, but he has been courteous enough to allow me to use the matter in this work.

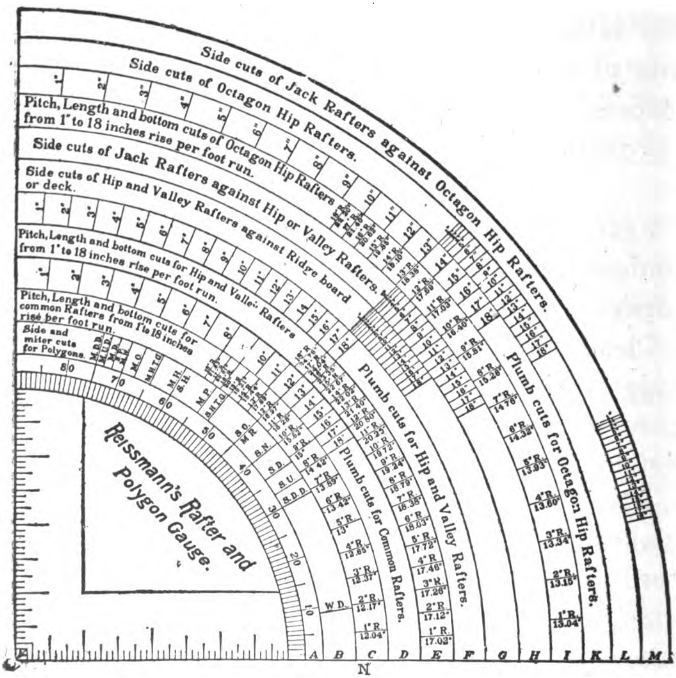


FIG. 30. REISSMANN'S RAFTER AND POLYGON GAUGE

Another great help to the workman is shown at Fig. 30. This is a rafter and polygon gauge, in which the figures are given for all kinds of cuts in rafters, hips, jacks, valleys for octagons or other polygons by aid of the table and a steel square. This instrument will give the correct

side and miter cuts for a pentagon, hexagon, heptagon, octagon, nonagon, decagon, undecagon and dodecagon; the length of common, hip, valley and octagon hip rafters; the pitch, plumb and side cuts for the above-named rafters; the side bevel of jack rafters against hip and valley rafters and also the side bevel of jack rafters against octagon hip rafters; the miter cuts for level planceer, crown moulding, sheathing and shingles for hip and valley; the degrees from 1 to 90, and a scale representing 1 inch to 1 foot. With this gauge 390 cuts and bevels may be obtained instantly and with minute accuracy. A little study and practice of this eminently useful article will prove it indispensable to every mechanic connected with the building industry.

This instrument is the invention of F. Reissmann, New York, from whom further information may be obtained. The instrument is covered by patents.

To obtain any desired angle in the construction of buildings and roofs apply the tongue of an ordinary carpenter's sliding T-bevel against the edge of gauge marked "N," then move the blade of bevel so that its outer edge will coincide with the arrow point on gauge marked "O"

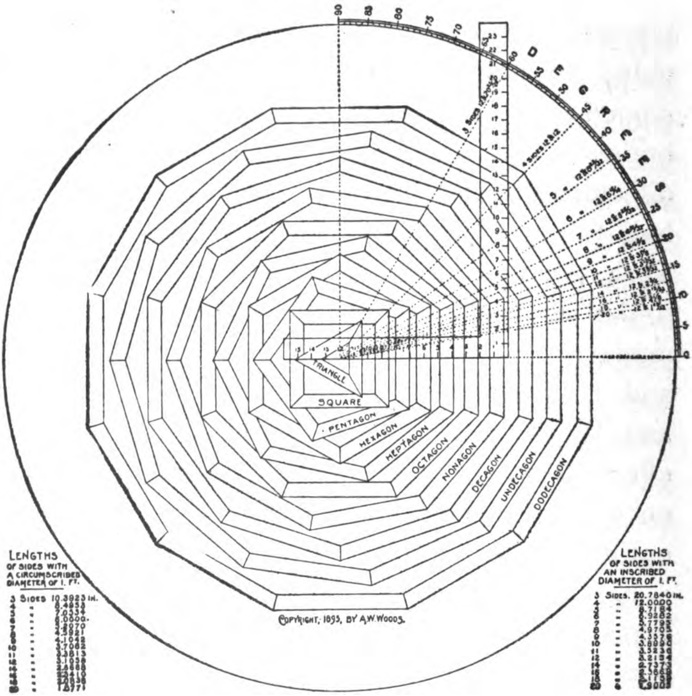
and the line from which the angle is to be taken.

This gauge measures 10x13 inches over all, and is made up of three-ply veneer, well glued together, and is highly polished, making it impervious to water. It is almost indestructible, and will last a lifetime. Full directions for using the gauge for all purposes are printed on the face of the instrument, so that the directions and the gauge are never apart. I have one of these gauges before me as I write, and am led, while explaining it, to indulge a moment in retrospect and wonder how much the mechanics of to-day owe to the men who invent and devise such instruments as those shown at Figs. 28, 29 and 30. Fifty years ago it was quite difficult to find a man who would undertake the construction of a complicated roof. And I have known of buildings having the work suspended for quite a while, because of no workman present being able or willing to undertake the putting on of the roof, and men had to be brought from a distance to do the work, and these imported men were looked upon as being quite superior beings. Workmen in those days knew nothing of the capabilities of the steel square. indeed there were no steel squares as we now know

them, only iron ones, imported from England or Belgium, and of very inferior manufacture. Now, with the aid of the perfected square, and the treatises thereon, and the instruments provided as above by the ingenious gentlemen named, almost any mechanic—if he have any brains at all—can lay out a roof no matter how difficult it may appear and construct the same in half the time it took our grandfathers to do the work, and the roofs are just as well constructed to-day as roofs were in the olden days. The modern mechanic has much to be thankful for, and he owes to men like Riddell, Reissmann and Woods a monument of gratitude for the efforts they have made in making what was once a very difficult affair, a most simple and easily understood operation.

Fig. 31 shows another very ingenious diagram, which in conjunction with the square, makes the obtaining of the angle-joints for any kind of a polygon quite an easy matter. This diagram requires no explanation, as the direction of the lines shows how the joints are found. The lines are also laid off in degrees, enabling the operator to make use of the lines or angles as degrees and minutes, or as arbitrary lines as he may determine. This diagram is the invention

of A. W. Woods, architect, and is a credit to his ingenuity and mathematical skill.



POLYGONS AND THEIR MITERS.
BY A. W. WOODS, AUTHOR OF THE SQUARE-ROOT DELINEATOR IN THE ART OF FRAMING

FIG. 31

THE FENCE

The first thing required in connection with the square is a "fence." This is a simple affair and may be of wood or of metal according to the

taste or wealth of the user. This device is a very old one, and has been the cause of considerable controversy as to its origin. In a series of articles I contributed to "The American Builder" in 1875, I illustrated and described this attachment, not claiming it as my own device, but giving it just as I had found workmen making use of it, and I was brought to task concerning it by a man named Joseph R. Gill, who claimed it as his own invention, having employed it, so he stated, in 1844. On this statement I at once wrote a letter to "The American Builder" stating the fact, as I then thought, giving the credit of the invention to Mr. Gill, and this letter was published in the journal in 1878, and brought from several parts of the country a number of protests, declaring that Mr. Gill was very much mistaken if he supposed he was the first originator of the fence.

One person writing from Springfield, Mass., says:

"I have just had brought to my notice an item in your paper, "The American Builder," written by a correspondent named Hodgson, that some man by the name of Gill claims to have invented the little attachment used on the steel square, which he calls a 'fence,' but which is known

down here as a 'guide.' Now, sir, my father was an old framer; he has been dead over fifty years, and when a boy I remember of his using a 'guide,' such as your correspondent describes in his letters on 'The Steel Square and Its Uses.' I served my time with my father, and made use of the same scheme long before Mr. Gill could possibly have used it, unless he is a very old man—for I have entered my fourth score year—and I used the square and guide before I was fourteen years old. Mind, I do not claim that my father invented the guide, nor do I know where he got the idea from, but I imagine it was quite a common thing among carpenters long before my father's time.

"Excuse the length of this, but I thought it best to correct an error even if it is a trivial one.

"Respectfully yours,

"John Willars.

"Springfield, Mass., Sept. 16, 1878."

Several of these letters were forwarded to me by the then editor of "The American Builder," Chas. D. Lakey, Esq., and a few of them are still in my possession, the above being a copy of one of them.

I have thought the above necessary because this Mr. Gill, who was a very eccentric and

singular man, published a book in 1892, entitled, "Gill's Detail on the Square," which perhaps never would have been heard of had I not given it some publicity, and in its pages, which abound with eccentricities and fairy-like problems, he *cruelly* accuses me of appropriating his "thunder" and stealing his fence, and devotes nearly two pages of the seven, which go to make up his book, in showing how unjustly he had been treated because of the omission of his name in connection with this fence in the hundreds of thousands of volumes on the steel square bearing my name that have been scattered all over the country during the last twenty-five years.

So much for the history of the fence so far as I know it, and I trust my readers will understand that I do not claim that I originated it. I found it in general use among framers and described it as I found it.

The fence, which is adjustable, is shown at

FIG. 32. DOUBLE SLOTTED FENCE

Fig. 32, and is made from a strip of hardwood about 2 inches wide, 1½ inches thick and 2½ feet long. A saw kerf, into which the square will

slide, is cut from both ends, leaving about 8 inches of solid wood near the middle. The tool is clamped to the square by means of screws at convenient points as shown. Another style of fence, which is made of a piece of hardwood,

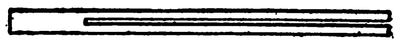


FIG. 33. SINGLE SLOTTED FENCE

has a single slot only as shown in Fig. 33. The square is slipped in and fastened in place by screws similar to the first. An application of the fence and square combined is shown at

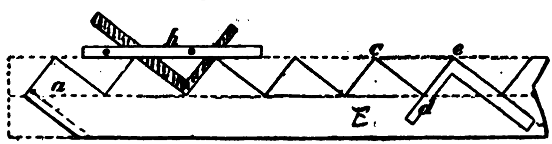


FIG. 34. SHOWING APPLICATION OF SQUARE AND FENCE IN LAYING OUT A STAIR STRING

Fig. 34, where the combination is used as a pitch-board for laying out stair strings. In this example the blade is set off at 10 inches, which makes the tread, and the tongue shows the riser, which is set off at 7 inches. The dotted line, *ce*, shows the edge of the plank from which the string is cut, and *h* shows the fence, *a* shows the bottom tread and riser. In this example the riser shows the same height as the riser above it, namely, 7 inches. This is wrong, as the first

riser should always be cut the *thickness of the tread less* than those above it, as shown by the dotted lines on the bottom of the string, then when the tread is in place it will be the same height from the top of the floor to the top of the first tread, that the top of first tread is to top of second one and so on.

Suppose we wish to lay out a rafter having eight inches rise and twelve inches run [illegible] the

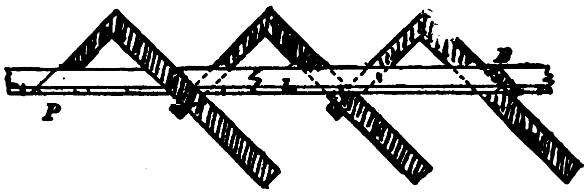


FIG. 35. SHOWING METHOD OF LAYING OUT RAFTERS TO A LINE

fence at the 8″ mark on the blade, Fig. 35, and at the 12″ mark on the tongue, clamping it to the square with 1¼″ screws. Applying the square and fence at the upper end of the rafter we get the plumb-cut P at once. By applying the square as shown twelve times successively the required length of the rafter and foot-cut B is obtained. In this case the twelve applications of the square are made between the points P and B. Run and rise must also be measured between these points. If run is measured from the point B, which will be the outer edge of the

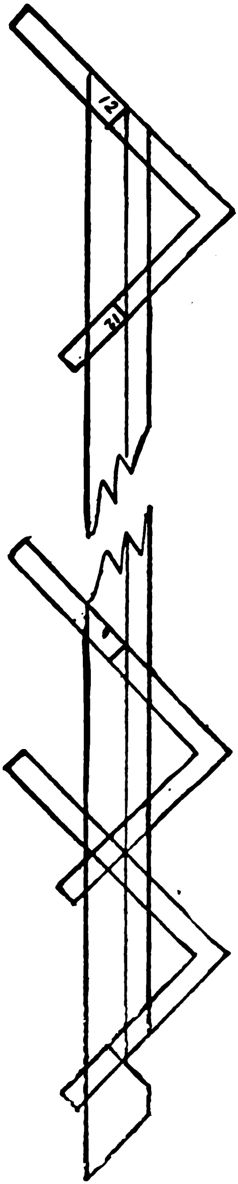


FIG. 36. SHOWING HOW TO LAY OFF A RAFTER WITHOUT MAKING USE OF A FENCE

wall plate, it will be necessary to run a gauge line through B parallel to the edge of the rafter, and subtract a distance from the height of the ridge to give us the correct rise. The square must then be applied to the line L. A rafter of any desired rise and run may be laid off in this manner by selecting proportional parts of the rise and run for the blade and tongue of the square. For a half-pitch roof use 12 in. on both tongue and blade, for a quarter-pitch use 6 in. and 12 in., for a third-pitch use 8 in. and 12 in., etc. The terms half-pitch, quarter-pitch, etc., refer to the height of the ridge expressed as a fraction of the span.

The line L is supposed to represent the path of the fence as it is slid along the

edge of the rafter. This will be explained at greater length in following pages.

At Fig. 36 I show a method of laying out a rafter without making use of a fence. In this case the roof is supposed to be half-pitch, so we take 12 and 12 on the square and apply it to the rafter as many times as there are feet in half the width of the building, which in this case will be 15 feet, as we suppose the building to be 30 feet wide. As the lower end of the rafter is notched to sit on the plate we must gauge off a backing line, as shown, to run into the angle of the notch. This line will be the line on which the gauge points 12 and 12 on the square must start from each time.

Starting from this notch apply the square, keeping the twelve inch mark on both sides of the square carefully on the backing line, and marking off the rafter on the outside edges of the square. Repeat this until you have fifteen spaces marked off, then set back from your last mark half the thickness of the ridge-board, and with the square as before mark off the rafter. This will be the exact length and also the plumb-cut to fit the ridge-board. Or if we take the diagonal of 12 by 12, which is 17, and mark off 15 spaces of 17 in., making the necessary

allowance for the half thickness of the ridge-board, it will amount to the same thing, every 17 in. on the rafter being nearly equal to one foot on the level.

Should the building measure 30 ft. 9 in. in width—the half of which is 15 ft. 4½ in.—we take the fifteen spaces of 12 by 12 and then the 4½ in. on both sides of the square on the backing line as before. This will give us the extra length required. The same rule will apply to any portion of a foot there may be.

A fence, sometimes called a stair gauge, is manufactured of metal by the Cheney & Tower Company, Athol, Mass., which I show at Fig. 37, and is considered about the best thing of the kind. It consists of a piece of polished angle metal, each side being ⅞ inch wide. One side is slotted to accommodate the heads of the set-screws and to allow the slides to be fastened at the desired points. The gauge is fastened to any square, and is useful for laying out stairs, cutting in rafters, cutting bevels or other angles. In marking off stairs with an 8-inch

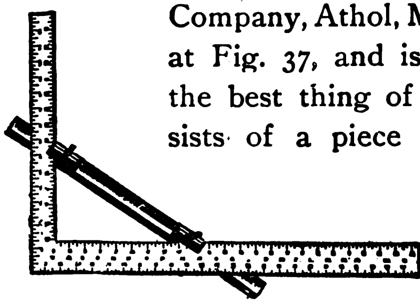


FIG. 37. SHOWING METAL FENCE

rise and an 11¾-inch tread the gauge would be fastened at 8 inches on one end of the square and at 11¾ at the other end. The square would then be laid on the plank with the face of the gauge against its edge and the mark made around the point of the square. This would be repeated until the required number of steps were marked. The gauges are made in two sizes, 18 and 28 inches long. It is stated that mechanics who have used it find it one of the handiest tools in their kits.

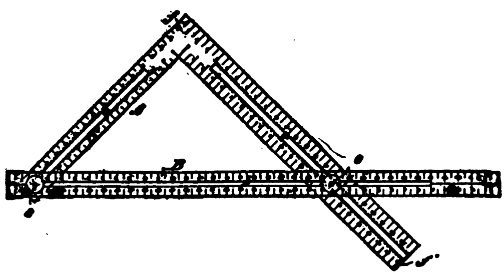


FIG. 38. FENCE AND SLOTTED SQUARE

Another style of fence is shown at Fig. 38 in conjunction with a slotted square. This, perhaps, is the handiest of all the devices for a fence, but it is expensive, and as constructed requires a square with a slot in each arm, and as a rule workmen do not take kindly to squares with slots in them. A shows the square, B the fence, SS set screws to hold the fence in position, and *ff* the points of the square.

The application of the square and fence combined for laying out a housed string for stairs is shown at Fig. 39. In this example the fence is a single slotted one, and three screws are employed to hold the square in position. The rise is seven inches and the tread is laid off nine inches on the blade. The square at the foot of the string shows how the latter should be finished to make the floor and the base-board. In this case no pitch-board is required, as the square when adjusted with fence, as shown, does the work of the pitch-board.

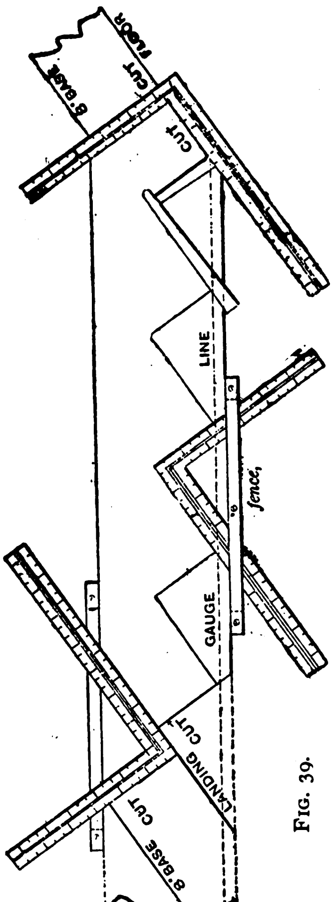


Fig. 39.

Showing Application of Square and Fence in Laying Out a "Housed" String

There are many other applications of the fence in connection with the square that I

may have cause to refer to as I proceed, as it is my desire to present in this work everything I can collect regarding the square that I think will be of service to the workman. Doubtless there will be many descriptions and illustrations some of my readers will have met with before, or which they have been acquainted with for a long time. The great bulk of readers, however, will be new hands, and unacquainted with the use of the square beyond its simple application as a squaring tool, and what may appear to be a useless rule to the expert or old hand will prove a choice tidbit to the beginner and will whet his appetite for further knowledge on the subject. Indeed this book is prepared more particularly for the younger members of the craft, although a majority of the older workers will find much in it that will interest, amuse and instruct.

It will be seen that the fence or guide used in connection with the square is, after all, a very simple matter, and would, no doubt, suggest itself to any clever workman who was laying off rafters with the square, and it is very likely that the fence originated in the minds of many men —Mr. Gill included—but I must confess that it is such a simple matter that it is not worthy of the

attention paid to it or its origin that Mr. Gill and others have given it.

BRACE RULES

It will now be in order to show how the square can be used for getting the lengths and bevels for braces of regular and irregular runs. If we wish to lay out a brace having a three-foot run on both post and beam, the matter is quite simple, for we can take 12 inches on the tongue and 12 inches on the blade and transfer this distance three times on a straight line and we have the extreme length of the brace from point to point, and by marking along the blade at one end of this length and along the tongue at the other end we also get the bevels. This is easy and simple enough, and without further refinements will give the lengths and bevels exactly for a flat-footed brace. When the run is

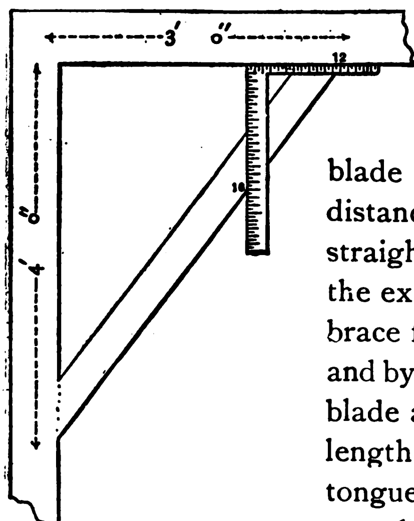


FIG. 40. SHOWING CUTS AND LENGTH OF AN IRREGULAR BRACE

different than the rise, as in the example shown at Fig. 40, the square is applied in a somewhat different manner. Here we have a run of three feet and a rise of four feet. To get the proper length and bevels for a brace to fit in this situation we must use 12 inches on the tongue and 16 inches on the blade, then the bevel of the upper end of the brace will be found along the line of the tongue, and the line of the blade will give the bevel for the foot of the brace. In this case the square is transferred three times, just as though the rise and run were both three feet; the difference being made by dividing the odd foot into three equal parts of 4 inches each and adding one part to the blade, thus making the gauge point on the blade 16 inches instead of 12 inches, which regulates the extra length and the change in bevels. A little study on the part of the reader will reveal to him how the square may be set to gauge points so as to make a brace suitable for any rise and run of any right-angled frame work.

A brace intended for equal run and rise of four feet is shown at Fig. 41. Here we have the fence in use, and the square is shown in all its positions from start to finish in the formation of the brace. The gauge line marked *oooo* is

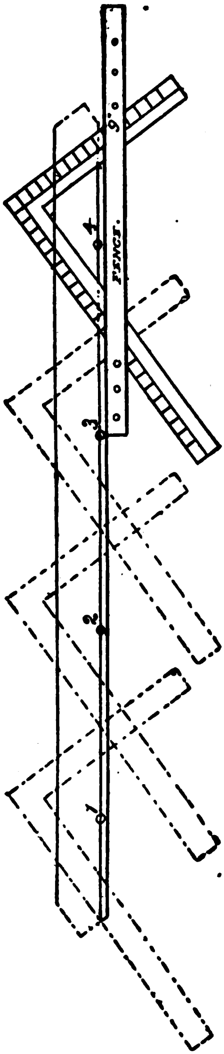


FIG. 41

the line from which the marks 12 and 12 are supposed to measure, and this when squared over as shown leaves a butt, or "heel of the brace," which is to rest on a shoulder "boxed" in both beam and post. The dotted lines on the ends of the brace show the tenons for which mortises are made in both post and girt or beam. It must be understood, of course, that this operation is only performed once for each kind of brace, and that on a pattern made of some kindly wood, such as pine, cedar or whitewood. For the pattern, dress up a piece of the wood to 4 inches wide if the braces are to be made of 4x4-inch stuff; if for larger or smaller stuff then make the pattern the width of brace to suit. Have the pattern of sufficient length; if for a 4-foot run and rise it will require to be

not less than 6 feet long. Run a gauge line three-eighths of an inch from the straight or front edge, as shown at oooo, and set the two 12-inch marks on this line, then screw the fence tight on the square with its sliding edge against the edge of the pattern, and then slide and mark as shown four times, when the length and bevels of the brace will be obtained. Provide for the tenons beyond the lines shown by the square, or for a '"flat-foot" brace, saw the timber off on the lines shown on the edge of the square. After the pattern is made the fence and square may be laid aside, as the pattern can be used for any number of braces, and when finished with on one job, may be safely placed away to use again for the same "run and rise" when occasion arises. The pattern may be any thickness from half an inch to one inch. The same rules may be observed in making patterns for any regular or irregular runs and rises.

With regard to the *brace rule* as given on steel squares, I may say that there is some slight difference in the lengths given by different makers—though nearly all modern makes figure up alike—but this difference is so small that in soft wood framing it has no effect. In hard-

wood framing the framer never ápplies these rules, but gets his lengths with the square and fence.

The length of any brace simply represents the hypothenuse of a right-angled triangle. To find the hypothenuse extract the square root of the sum of the square of the perpendicular and horizontal runs. For instance, if 6 feet is the horizontal run and 8 feet the perpendicular, 6 squared equals 36, 8 squared equals 64, 36 plus 64 equals 100, the square root of which is 10. These are the figures generally used for squaring the frame of a building or foundation wall.

If the run is 42 inches, 42 squared is 1764, double that amount, both sides being equal, gives 3528, the square root of which is, in feet and inches, 4 feet 11.40 inches.

In cutting braces always allow in length from a sixteenth to an eighth of an inch more than the exact measurement calls for.

Directly under the half-inch marks on the outer edge of the back of the tongue will be noticed two figures, one above the other. These represent the run of the brace, or the length of two sides of a right-angled triangle; the figures immediately to the right represent the

length of the brace or the hypothenuse. For instance, the figures $\frac{36}{36}$ 59.91 show that the run on the post and beam is 36 inches, and the length of the brace is 50.91 inches.

Upon some squares will be found brace measurements given where the run is not equal, as $\frac{18}{24}$ 30. It will be noticed that the last set of figures are each just three times those mentioned in the set that are usually used in squaring a building. So if the student or mechanic will fix in his mind the measurements of a few runs, with the length of braces, he can readily work almost any length required.

Take a run, for instance, of 9 inches on the beam and 12 inches on the post. The length of brace is 15 inches. A run, therefore, of 2, 3, 20, or any other number of times the above figures, the length of the brace will bear the same proportion to the run as the multiple used. Thus, if you multiply all the figures by 4 you will have 36 and 48 inches for the run, and 60 inches for the brace, or to remember still more easily, 3, 4 and 5 feet, or 6, 8 and 10 feet.

There are other runs that are just as easily fixed in the mind. 51-inch run, brace 6 feet, 12 hundredths of an inch; 8 feet, 3-inch run, brace 11 feet, 8 inches, etc.

This completes the description of brace rule on the square, so far, but I will revert to the subject again. Every mark, line and figure has been carefully considered, and a full explanation given of their use and meaning. I have taken more space than was at first intended, owing to an anxiety to have every mark thoroughly explained, so that even a beginner could pick up a square and be able to explain to anyone the use and meaning of every figure. This part of the subject has been more for the benefit of the younger workmen, but I am sure the older ones will appreciate the explanations.

The following brace table has been carefully prepared and may be depended upon as giving correct measurements:

TABLE

Length of Run						Length of Brace		Length of Run						Length of Brace	
ft.	in.		ft.	in.		ft.	in.	ft.	in.		ft.	in.		ft.	in.
	6	×		6	=		8.48	4	3	×	4	3	=	6	0.12
	6	×		9	=		10.81	4	3	×	4	6	=	6	2.27
	9	×		9	=	1	0.72	4	3	×	4	9	=	6	4.49
1	0	×	1	0	=	1	4.97	4	3	×	5	0	=	6	6.74
1	0	×	1	3	=	1	7.20	4	6	×	4	6	=	6	4.36
1	3	×	1	3	=	1	9.23	4	6	×	4	9	=	6	6.51
1	3	×	1	6	=	1,	11.43	4	6	×	5	0	=	6	8.72
1	6	×	1	6	=	2	1.45	4	9	×	4	9	=	6	8.61
1	6	×	1	9	=	2	3.65	4	9	×	5	0	=	6	10.75
1	9	×	1	9	=	2	5.69	5	0	×	5	0	=	7	0.85
1	9	×	2	0	=	2	7.89	5	3	×	5	3	=	7	5.09
2	0	×	2	0	=	2	9.94	5	6	×	5	6	=	7	9.33
2	0	×	2	3	=	3	0.12	5	9	×	5	9	=	8	1.58
2	0	×	2	6	=	3	2.41	6	0	×	6	0	=	8	5.82
2	3	×	2	6	=	3	4.36	6	3	×	6	3	=	8	10.06
2	6	×	2	6	=	3	6.42	6	6	×	6	6	=	9	2.30
2	6	×	2	9	=	3	8.59	6	9	×	6	9	=	9	6.55
2	9	×	2	9	=	3	10.66	7	0	×	7	0	=	9	10.79
2	9	×	3	0	=	4	0.83	7	3	×	7	3	=	10	3.03
3	0	×	3	0	=	4	2.91	7	6	×	7	6	=	10	7.28
3	0	×	3	3	=	4	5.02	7	9	×	7	9	=	10	11.52
3	0	×	3	6	=	4	7.31	8	0	×	8	0	=	11	3.76
3	0	×	3	9	=	4	9.62	8	3	×	8	3	=	11	8.00
3	3	×	3	3	=	4	7.15	8	6	×	8	6	=	12	0.24
3	3	×	3	6	=	4	9.31	8	9	×	8	9	=	12	4.49
3	3	×	3	9	=	4	11.54	9	0	×	9	0	=	12	8.73
3	3	×	4	0	=	5	1.84	9	6	×	9	6	=	13	5.22
3	6	×	3	6	=	4	11.39	10	0	×	10	0	=	14	1.70
3	6	×	3	9	=	5	1.55	10	6	×	10	6	=	14	10.19
3	6	×	4	0	=	5	3.78	11	0	×	11	0	=	15	6.67
3	9	×	3	9	=	5	3.63	11	6	×	11	6	=	16	3.16
3	9	×	4	0	=	5	5.79	12	0	×	12	0	=	16	11.64
4	0	×	4	0	=	5	7.88	12	6	×	12	6	=	17	8.13
4	0	×	4	3	=	5	10.03	13	0	×	13	0	=	18	4.61
4	0	×	4	6	=	6	0.25	13	6	×	13	6	=	19	1.10
4	0	×	4	9	=	6	2.51	14	0	×	14	0	=	19	9.58
4	0	×	5	0	=	6	4.83								

SOME PRACTICAL EXAMPLES OF THE USES OF THE SQUARE

The following applications of the square were published by Mr. John O'Connell, of St. Louis, Mo., in the "Scientific American Supplement," September, 1877, along with much other matter concerning the square. While I do not purpose giving all of Mr. O'Connell's paper I think it but fair to my readers to lay before them those portions of it which I think will be interesting and instructive. In connection with this paper it must be understood that the squares in use in 1877 were not figured as squares are to-day, and while the matter given is correct on the whole, there may be some little confusion in the figuring of the lumber rule, but this is not serious.

THE OCTAGONAL SCALE

The octagonal scale is shown by Fig. 41. It is on the opposite side of the tongue. It is used in this way: If you have a stick 10 inches square

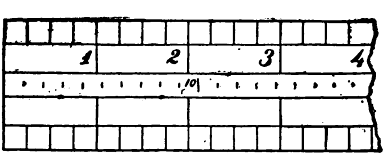


FIG. 41½

which you wish to dress up octagonal make a center mark on each face, then with the com-

passes take ten of the spaces marked by the short cross lines in the middle of the scale, lay off this distance each side of the center lines. Do the same at the other end of the stick and strike a chalk line through these marks. Dress off the corners to these lines, and the stick will be octagonal. If the stick is not straight it must be gauged and not marked with the chalk line. Always take a number of spaces equal to the square width of the octagon in inches. This scale can be used for large octagons by doubling or trebling the measurements.

To Find the Number of Inches to Take on Blade and Tongue for a Given Rise and Run of a Brace. —Divide the shorter rise or run of the brace or rafter into a number of equal parts, each part not to exceed the length of the tongue of the square. Divide the longer rise or run into the same number of parts, each part not to exceed the length of the blade, and if it does, divide the shorter rise or run into a greater number of parts. Example: A rafter with a run of 10 feet and a rise of 6, 12 inches on tongue and 20 on blade taken six times will give the length and bevels; or 15 and 9, taken eight times. When a brace or rafter is too long to be conveniently worked in this way take a half or a third of both

rise and run, and take two or three times the answer.

When you find the number of inches to take on the square lay the latter on a straight edge or line and find what diagonal length it gives. This multiplied by the number of parts in rise or run gives the whole length of brace.

To Find a Circle Equal in Area to Two or More Circles, Fig. 42.—Let A be ¾ inches or feet in diameter, and B 1¼. Measure across from the ¾ inch on one arm of the square to the 1½ inch on the other. This distance is the diameter of the required circle, C. If there were three circles we should set the diameter of the third on the tongue and that of C on the blade, and the diagonal distance between these points would be the diameter of a circle equal to the three, and so on for any number. This applies to squares also. By this simple rule we can find the size of one pipe equal to two or more, and square spouts in like manner, for grain elevators, for flour mills, or similar work. Similar figures of all kinds may be worked by this method—

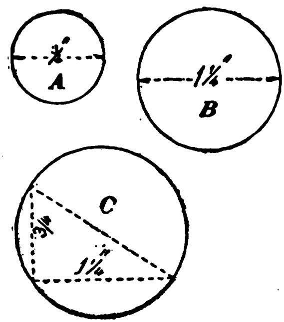


FIG. 42

triangles, rectangles, hexagons, octagons, etc.—taking similar dimensions only, that is, if the shortest side of one triangle is taken, the shortest side of the other must be taken also, and the answer gives the shortest side of the required triangle.

Three Points Not in a Straight Line Being Given to Find the Center of a Circle Which Will Pass through Them, Fig. 43.—Let 1, 2 and 3 be the points. Connect them by straight lines, and square from half the distance between them as at *d* and *e*. The intersection of these perpendiculars is the center.

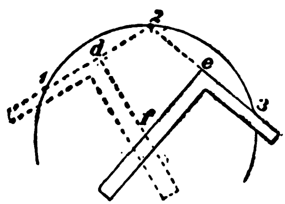


FIG. 43

To Find the Center of a Circle with a Square, Fig. 44.—Lay the square on the circle with the corner at the circumference. Mark where outer edge of tongue and blade cut the circle, and draw a line connecting these points. This line is always a diameter, and by drawing in like manner a diameter in another direction the intersection of the two gives the center.

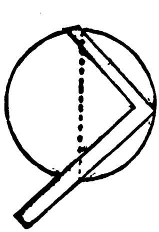


FIG. 44

To Find the Side of a Square of Half the Area of a Given Square, Fig. 45.—Let G be the given

square; half its diagonal gives the side of the

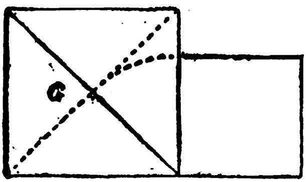


FIG. 45

smaller square. A square constructed on the diagonal of G would contain double the area.

To Lay off Angles of 60° and 30°.—Mark any number of inches, say 14, on an indefinite line. Place the blade against one extremity of this distance and the 7-inch mark of the tongue at the other. The tongue then forms an angle of 60° with the indefinite line, and the blade an angle of 30°.

To Lay Off an Angle of 45°.—A diagonal line connecting equal numbers on both arms of the square forms angles of 45° with the arms.

The Hypothenuse and One Side of a Right-Angled Triangle Being Given, to Find the Other, or Two Sides Being Given to Find the Hypothenuse.—Find in a manner similar to the rule for obtaining the length of a brace. For example, let the hypothenuse be 15 inches and one side 7½ inches, to find the other. Dividing these dimensions by three we have 5 inches for the side and 2½ inches for the hypothenuse. Mark off the 5 inches on the edge of a board or a straight line, as in Fig. 46. Lay the square with the 12-inch mark at *b*,

and move the blade till it touches the other 5-inch mark at *a*. From *a* to *c* is found the length, which multiplied by 3 gives the hypothenuse.

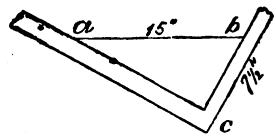


FIG. 46

To Lay Off an Octagon in a Square, Fig. 47.—Draw the diagonals *e* and *f*. Mark off the distance from the corner to the center *g* on all sides, measuring from the corners. The resulting marks give the corners of the octagon.

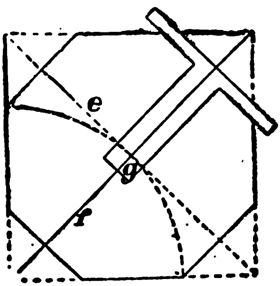


FIG. 47

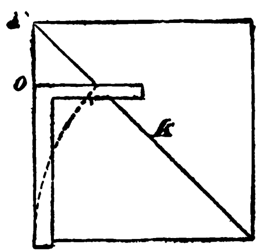


FIG. 48

Fig. 48. Another method is to measure off the side of the square on its diagonal *k*. Square from a side to the point thus found on the diagonal, and *no* is the distance to be gauged from each corner to mark the corners of the octagon.

To Lay Off an Octagon on a Given Side, Fig. 49.—Prolong the given side *ab* and lay off an angle

of 45° at both *a* and *b*. The lines, 1, 2, are squared up from the given side, also lines 3 and 4. By applying the square to the other lines we get the remaining sides.

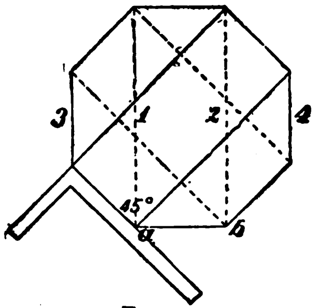


FIG. 49

To Make a Square Stick Octagonal, Fig. 50.—Lay the square or a two-foot rule diagonally across the stick so as to measure two feet on it, letting the

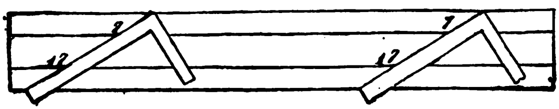


FIG. 50

corners on the same side of the blade or rule touch the edges of the stick. Make marks at the 7-inch and the 17-inch marks. Measure thus at each end of the stick. Lines struck through these points show what is to come off to make it octagonal.

To Find the Side of an Octagon When the Side of the Square Is Given.—Multiply the side of the square by 5 and divide by 12. The quotient is the side of the inscribed octagon.

When the Side of the Octagon Is Given, to Find the Square Width.—Suppose the side of the

octagon is to be 16 feet, take half this, or 96 inches, for the square, 16 inches on both tongue and blade taken six times, giving 11 feet 3¾ inches, which being doubled and added to the side of the octagon gives the square width.

Given the Square Width, to Find the Diagonal, Fig. 51.—Take half the square width and half the side on the square, or proportional parts, double what is found from these and the result is the diagonal.

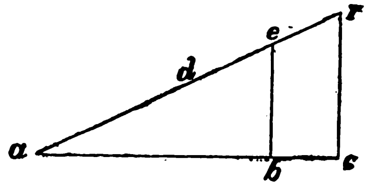


FIG. 51

To Find the Bevels and Width of Sides and Ends of a Square Hopper, Fig. 52.—The large square represents the upper edges of the hopper, and the small one the lower edges, or base. The width of the sides and ends is found in this way: Take the run, *ab*, on the tongue and the perpendicular height, *ad*, on the blade. It is thus found in the same manner as the length of a brace. To find the cut for a butt joint take width of side on blade and half the length of the

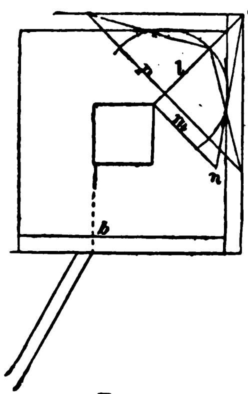


FIG. 52

base on tongue; the latter gives the cut. For a miter joint take width of side on blade and perpendicular height on tongue; the latter gives the cut.

For the cut across the sides of the boards take the run *ab* on the tongue and the width of side on blade; the tongue gives the cut. The inside corners of the side and ends are longer than the outside, so if a hopper is to be a certain size the lengths of ends and sides are to be measured on the inside edge of each piece and the bevels struck across the edges to these marks. This is only in case of butt joints. Of course if the hopper is to be square the thickness of the sides must be taken from the ends.

If the top and bottom edges are to be horizontal the bevel is thus found: Take the perpendicular height of hopper on the blade and the run on the tongue, the latter gives both cuts. A hopper can be made by the above method by getting the outside dimensions at top and bottom and the perpendicular height.

In large hoppers pieces are put down along the corners to strengthen them. The length and the bevel to fit the corners are thus found: Suppose the top of hopper is 8 feet and the bottom 18 inches square. Find the diagonals of

each, subtract the one from the other and half the remainder is the run for the corner piece. From the length of this run, *l*, and the rise, *ab*, we find the length of the corner piece. To find the bevel or backing take on the blade the length of the corner piece and on the tongue the rise; the latter gives the bevel. Another method is to draw the line *l* to represent the seat of the corner piece, set off square with this the line *m* of the same length as the run *ab*. Then draw *no*, which is the length of the corner piece. To find the backing draw a line, *p*, anywhere across *l* at right angles therewith, and at its intersection with line *l* strike a circle tangent to *no*. From the point of intersection of the circle with *l*, draw lines to the extremities of *p*. The angle made by these lines is the bevel or backing.

Another method generally employed for finding the bevels of hoppers is to bevel the top and bottom edges of the sides and ends to the angle they are to stand at, then to lay a bevel set to a miter, or angle of 45°, on the beveled edge, and that will lay off a miter joint, while a try-square will lay off a butt joint. An angle of 45° will miter only those boxes with sides which are vertical and square with each other.

When the sides and ends of a rectangular box

or hopper are of the same width, that is, when sides and ends slope at equal angles, the bevels, either butt or miter; are found as for square hoppers.

When a hopper has the sides and ends of different widths, that is, when sides and ends stand at different angles, both having the same rise, find the cuts for each from its respective rise, run and width.

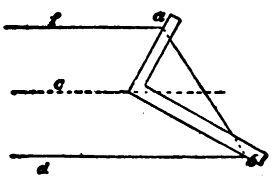


FIG. 53

Fig. 53. To bisect the angles *a* and *b* simultaneously with the square: Draw the center line *c*, place the corner of the square on this line and move blade and tongue to the angles, then draw the bisecting lines. This method is possible only when lines *d* and *f* are parallel.

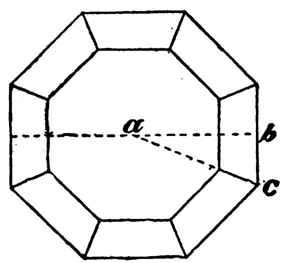


FIG. 54

Fig. 54 shows how the angles for an octagon plan may be obtained. *a b* is a line of diameter, and *a c* the line of angle required.

ROOFING

Fig. 55. A hip roof with two corners out of square is given as an example, the dimensions of

which are: Width, 15 feet; rise of roof, 5 feet;

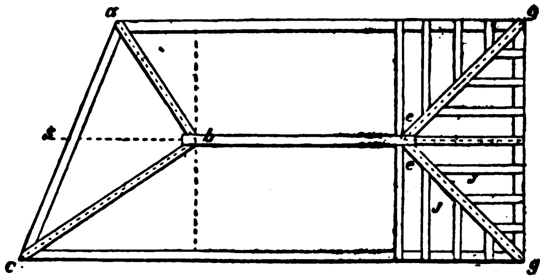


FIG. 55

length, 30 feet on the shorter side; 33 feet on the longer. The timbers, *ab*, *cb*, *cg*, *eg*, are the hip rafters; JJ the jack rafters. The seats of each hip rafter should form a square, so that each pair of jack rafters, JJ for instance, may be cut of equal length.

Lengths and Bevels of Hip Rafters.—We will first consider those on the square end of the roof. In order to find their length it is first necessary to obtain their run, which is found as follows: Take half the width of building on both blade and tongue, whence is obtained the length of seat from *g* to *e* at the intersection of the dotted lines. By similar use of the square this length with the rise of roof gives the length of the hip rafter. The lengths of all the rafters should be measured along the middle, as the dotted lines show. This is the full length; half

the thickness of the ridge-pole is to be taken off, measured square back from the bevel.

The bevel of the upper end of a hip rafter is called the down bevel. It is always square with the lower end bevel, hence these bevels are found by the parts taken on the square to find the lengths of the hip rafters. Another method is to take 17 inches on the blade and the number of inches of rise to the foot, that is, the rise in inches divided by half the width of roof in feet on the tongue. The tongue gives the down bevel, the blade the lower end bevel. The reason for the foregoing is that when the hip rafters are square with each other the seat of the hip is the diagonal of a square whose side is half the width of building. The diagonal of a square with a 12-inch side is nearly 17 inches. So if the rise of roof in 1 foot is 6 inches the rise of hip rafter will be that only in 17 inches. The directions here given assume that the hip rafter abut the ridge-pole at right angles, but as the ground plan of the roof shows that they meet at an acute angle another bevel must also be considered, called the side bevel of the hip rafters. Were there no slope to the roof the bevel where they meet the ridge-pole would be an angle of 45°, as the hips would be square with each

other. When a pitch or slope is given the hips depart from the right angle and, therefore, the side bevels are always less than 45°. Take the length of hip on the blade, and its run on the tongue; the blade gives the cut.

Backing of the Hip Rafters.—The backs of the hip rafters must be beveled to lie even with the planes of the roof. This bevel must slope from the middle toward either side. It is found by taking the length of hip on blade and the rise of the roof on tongue. The latter gives the bevel.

To Find the Lengths of the Jack Rafters.—Suppose there are to be four between the corner and the first common rafter; then there are five spaces, which, by dividing 7 feet 6 inches by 5, are 1 foot 6 inches, from center to center of jacks. The rise of roof also divided by 5 gives 1-foot rise for the shortest rafter. The run is 1 foot 6 inches, as both rise and run are given the length down and lower bevels are found therefrom. The next jack has double the rise, run and length of the first; the following one three times, and the fourth four times. All the measurements are to proceed on or from the middle lines of the jacks.

The side bevel of all the jack rafters is obtained by taking the length of a common

rafter on the blade and its run on the tongue; the bevel on the blade gives the result.

Let us now consider the end of the building out of square. Fig. 55 illustrates the method of laying down the seats of the hips. To find the length of these hips the lengths of the seats must be got by taking half the width of building on blade and the distance from the end of the dotted line crossing the roof to the corner on the tongue. The length of the seat so obtained taken on the square, with the rise of the roof, gives the length of the respective hip rafter.

The down and lower end bevels are found as in the previous hip rafters. To obtain each side bevel add the distance from the dotted line to the corner and the gain of the hip rafter; take the sum on the blade and half the width of building on the tongue; the latter gives the cut.

The lengths, etc., of the jack rafters on the side are determined as at the square end of the roof; the side bevel being found by taking the length of a common rafter on the blade, and the distance from the dotted line to corner on the tongue, the latter showing the bevel.

The Lengths of Jack Rafters on the End.—Assuming there are to be four jacks between the corner and the center included, half the length of the

end of the roof must be divided by 5. One side of the roof being 3 feet longer than the other, we place 3 feet on tongue and 15 feet—the width of building—on the blade, and thus obtain the distance from corner to corner on the end of the roof. Half this divided by 5 gives the distance of the jacks apart. The distance, from where the middle lines of the hips meet in the middle point of the end of the roof, is also to be divided by 5, the quotient giving the run of the shortest rafter. The rise is the same as for the jacks on the square end.

These rules give the full length of rafters, so that when hips come against a ridge-pole or jacks against a hip half the thickness of pole or hip, squared back from their down bevels, must be taken off.

Side bevels of these jacks are obtained by adding the distance from the dotted line to the corner to the gain of a common rafter in running that distance; take this on the blade and half the width of building on the tongue. The blade gives the bevel.

OCTAGONAL AND HEXAGONAL ROOFS

Fig. 56 represents an octagonal roof. In its construction the suggestions on octagons, pre-

viously made, must be referred to. The length of hips is found as usual from rise and run, the run being half the diagonal of the octagon. Cut the first pair full length to butt against each other, the next pair are to be set up at right angles to these, and each is to be cut shorter than the first pair by half the thickness of first pair measured square back from the down bevel.

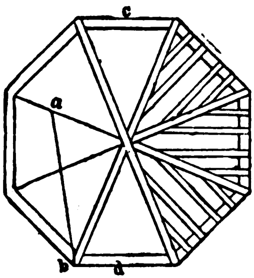


FIG. 56

The third and fourth pairs are to be cut shorter than the first by half the diagonal of a square whose side is the thickness of the first rafter. If the thickness of the first pair is 2 inches then the third and fourth pairs are shortened by $1\frac{6}{16}$, as $2\frac{13}{16}$ is the diagonal of a square whose side is 2.

The first and second pairs have no side bevels; the side bevels of the third and fourth run back on both sides from the middle of the rafter. Find this bevel by taking the original length of rafter on the blade and its run on the tongue when the blade shows the cut. The backing of the hips is obtained by taking $\frac{6}{16}$ of the rise on the tongue and the length of hip on blade; the

latter giving the cut, for the side of an octagon is $\frac{5}{12}$ its square width.

Half the square width is the run of the middle jack rafter, from which and the rise we get its length. From the length deduct the same amount as from the third and fourth pairs of hips. If there are to be two jacks between the middle one and the corner we divide the length of side into three parts, also the rise, whence are obtained, as before, the distance of rafters apart and the rise of shortest jack. Divide half the square width of octagon by three to find the run of shortest jack. Just as the square is laid on to find the length of a jack it gives the down and lower end bevels, while the side bevel is obtained by taking length of middle jack on blade and half one side of the octagon on the tongue; the blade giving the cut.

A HEXAGONAL ROOF

The side of a hexagon equals the radius of the circumscribing circle. The square width, or apothem, is determined from one side and a diagonal of the hexagon.

The first pair of hips are set up as in the octagonal roof. The second and third pairs have a side bevel. To find this take half the

side of the hexagon on the tongue, and half the square width added to the gain of the hip rafter in running that distance on the blade. The tongue gives the cut. Strike the bevel across the rafter. Now the second and third pairs are to be measured back shorter than the first pair on their middle lines, just half the length of this bevel. The third pair has the bevel cut on both sides from the center. The backing of the hips is found by taking $\frac{7}{12}$ the rise of roof on the tongue, and the length of hip on blade; the latter gives the cut. The side of a hexagon is $\frac{7}{12}$ its square width or apothem. The lengths and bevels of the jack rafters are found as in octagonal roofs.

TRUSSES

Fig. 57, *a* is the straining beam, *b* the brace, *t* the tie-beam. Generally the brace has about one-third the length of tie-beam for a run. From the rise and run find the length and lower end bevel of the brace. After making the lower end bevel on the stick add to it just what is cut out of the tie-beam. The bevel of the upper end of

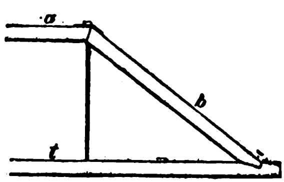


FIG. 57

the brace where it butts against the straining beam is found in the following manner: Take the length of the brace, or a proportional part, and mark it on the edge of a board; take half the rise of the brace on the tongue, lay it to one of these marks on the board, and move the blade till it touches the other mark on board. A line drawn along the tongue gives the bevel for both brace and straining beam. The angle made between brace and straining beam is thus bisected. Lay off the measurements from the outside of the timbers. Put a bolt where shown with a washer under the head to fit the angle of straining beam and brace.

PLAIN STAIRS

See Fig. 34. First determine the height from the top of the floor on which the stairs are to be placed to the top of the floor above, also the run of the stairs. It is necessary to plumb down from the top to get the run or horizontal distance correct. The stringers for stairs are cut top and bottom, like a brace of same rise and run, of course measuring along the inner dotted line as you would measure a brace if the point were to be cut off and let into the post or beam.

Suppose the vertical height to be 10 feet

4 inches, and the rise for each step is required to be about 8 inches; divide the height in inches by 8 to obtain the number of steps. The quotient is 15½. As it is not advisable to have a half step make the number of steps 16, and dividing the total height in inches by 16 we obtain 7¾, the rise in inches of every riser or step. Suppose the run of the stairs is 10 feet 5 inches; divide this distance in inches by the number of steps, which is one less than the number of risers, as the upper floor forms a step to the last riser. The quotient, 8⅓ inches, is the net width of each step; to this there being generally added 1½ inches or so for nosing or projection.

If it is not desired to plane up the edge of the stringer strike the chalk line, *ab*, about the proper distance from the edge, and lay the square on this mark, as at *d*, taking the width of step on one arm and the rise of step on the other. If the edge of the board is dressed straight the square may be laid on as at *h;* a piece of board with a slot sawed through edgewise, as shown by Fig. 32 or 33, when slipped on the square and fastened with screws, making a convenient contrivance for laying out stringers. Generally a piece of thin board is cut out in the

form *cde* with a piece nailed to the edge *c* for a guide. The bottom riser must be made less in height than the others by the thickness of the step. For instance, if the steps are 1½ inches thick, the bottom riser should be 7¾ inches less 1½ inches, or 6¼ inches in height. It is sometimes inconvenient to put a support under a long stair. In that case the triangular piece, *cde*, should not be cut out, but a groove made of same form, with a width equal to the thickness of the step and a depth of about half an inch. When the steps are well fitted into these grooves, and ⅝ inch bolts, with nuts, are run through across the stringers at about every five feet in length and passing close under the steps, the stairs are made very rigid when the bolts are well tightened.

HEXAGONAL AND OCTAGONAL BOXES OR HOPPERS

The cuts for the edges of the pieces of a hexagonal hopper are found by subtracting the width of one piece at the bottom, viz., the width of same at top, and taking the remainder on the tongue and depth of side on blade. The tongue gives the cut. For the cut on the face of the sides take $\frac{7}{13}$ of the rise on the tongue and the depth of side on the blade. The tongue gives

the cut. The bevel for the top and bottom edges is found by taking the rise on the blade, and the run on the tongue; the latter gives the cut.

To find the cut of an octagonal hopper for the face of the board and also the edge subtract the rise from the width of side; take the remainder on the tongue, and width of side on blade; the tongue gives the cut. The edge of the stuff is to be square when applying the bevel. The bevel for the top and bottom edges of the sides are found by taking the rise on the blade, and the run on the tongue; the latter giving the cut. This makes the edges horizontal. The edges are not to be bevelled till the four sides are cut.

CONVEYORS

Let us assume a conveyor in a flour mill or elevator to have the following dimensions: Diameter of shaft, 5 inches; length, 14 feet; pitch of flights or screw, 7 inches. Next cut a piece of stiff paper of form of Fig. 58. The length of this pattern is equal to the circumference of the shaft, 5x3.1416, or about 15.71 inches. The vertical side of the triangle

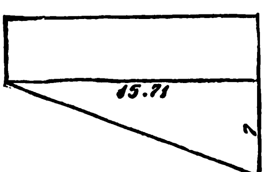


Fig 58

shown on the pattern is the pitch of the conveyor, or 7 inches. The hypothenuse of this triangle is the length of the spiral for one round. Lay off the pattern lines on both sides of the paper. Draw a line on the shaft parallel to its axis. Lay even with this line the 7-inch side of the pattern triangle, wind the pattern around the shaft and draw the course of the spiral along the hypothenuse; continue the spiral by shifting the pattern 7 inches further on. To find the whole length of the spiral we first determine how many times the length of shaft contains the pitch; the quotient is 24. This number multiplied by the length of the hypothenuse of the pattern is the total length of spiral.

If the shaft were octagonal but with the same pitch, we divide the pitch by the number of sides, which gives 7/8 inch for the pitch on one side. Take a short piece of board as wide as the diameter of the shaft, and taking 7/8 inch, or a multiple thereof, on the blade, and the width of one side of the shaft, or the same multiple thereof, on the tongue, place the blade even with the lower edge of the board at *ab*, Fig. 59, and draw the diagonal *bc*. Cut off the end of the board through

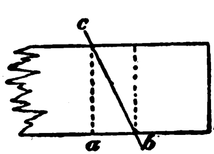


FIG. 59

this diagonal, tack a strip on the lower edge as a guide to rest against the side of the shaft. This pattern will now mark off the spiral, whether right-handed or left, on every side successively.

SAWING TIMBER

Fig. 60 shows how to find the largest rectangular stick that can be cut from a round log. Divide the diameter *ac* into three equal parts. Square out from these divisions by 2, to the circle representing the log and connect the points *a*, *b*, *c*, *d*.

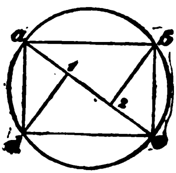


FIG. 60

SCALES

Fig. 61 shows another use for the square. If a person is drawing a machine on a scale of 1½ inches to the foot he may simply lay a common rule, *e*, under the square, touching the 12-inch mark on the blade and the 1½-inch mark on the tongue; he then possesses a contrivance by which he may easily reduce from one scale to the other. For instance, if a piece of stick 2¾ inches square is to go into the construction, the draftsman finds the 9¼-inch mark on the blade, that is, 2¾ inches back from the 12-inch mark, and measures square out to the rule, as at

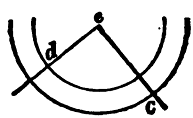


FIG. 61

d. This distance is the reduced section of the stick. A straight mark drawn on a table or a drawing board serves as well as a rule.

TO TEST A SQUARE

The square may be quickly tested by laying it on a wide board, placing the blade parallel to one edge, which must be planed perfectly straight, and drawing a fine line along the tongue. The square is then turned over so as to rest in a reversed position on the opposite side of the line just drawn. If the square now exactly coincides with the line and the board-edge, it is a perfect right angle. A great recommendation of this method is that an inaccuracy of the scale is doubled by the reversing and so made more apparent. If the square is not true it should be set in a vise and draw filed.

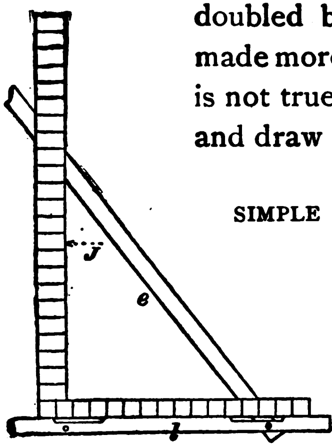


FIG. 62

SIMPLE CALCULATING MACHINE

Fig. 62 shows the application of a long bevel to a square by which some calculations can be made with greater ease and quickness than

by the usual arithmetical process. The largest size of carpenter's bevel square placed under the framing square will answer in nearly every case, or any mechanic can make the bevel for himself with blades of steel obtained at a hardware store. The edge of each blade should be made perfectly straight and the edge of *l* should be filed down in several places to see the blade *e* when placed under the square. If blade *e* were placed on the square it covers up the figures on the latter. The two blades should be fastened together by a thumb screw. There should be three holes in *l*, one near each end and one in the middle, and a notch filed by each hole, so that the blade *e* may be shifted when necessary.

These contributions to the literature of the steel square by Mr. O'Connell, while not altogether new when written, have done much toward popularizing the steel square, and have been the means of "drawing out" many good things on the subject from workmen all over the world where the English language is spoken, and they have been quoted and requoted in thousands of instances during the past twenty-five years.

Not only in the United States, Canada, and Australia is a knowledge of the capabilities of

the steel square becoming more diffused and generally understood among workmen, but also in conservative England, where some three or four works have recently been written on the subject, among which I may mention "Practical Roofing Bevels," specially prepared for the "Iron Square," by E. F. Bockham; "Roofing by the Iron Square," by Frank Nicholls; "The Use of the Steel Square for Obtaining Cuts in Carpentry," by Henry Parker.

In the introduction the author of the last named work says: "The square referred to in this work is what is generally known as the 'American Steel Square,' one side being 2 feet long and 2 inches wide, the other varies in length in different squares from 16 inches to 18 inches and 1½ inches wide; the long side is called the blade, the shorter side the tongue, the outer corner of the square is called the heel. On one side on outer edge of square the inches are divided into eight parts, the other side on the outer edge the inches are divided into twelve parts, the side with the inches divided into twelve parts is the side that should be used for finding lengths and bevels, as each inch represents a foot, this scale being most convenient."

This is a fairly correct description of *some*

makes of American Steel Squares, but does not by any means cover the whole ground. Further on I will give some examples from these works, which I am sure will both interest and instruct my readers.

Besides the works named, there have been many articles of more or less value regarding the square and its uses in the English trade papers, in which the writers have evinced a very fair knowledge of the tool and its applications. The manner of using the square for the solution of some of the every-day problems is sometimes different from that employed in America, but results are about the same.

The following article and illustrations, which are taken from "The Illustrated Carpenter and Builder," a very useful journal published in London, England, will give the reader some idea of how steel square matters are treated by practical men in the old country. In describing the square the writer starts off by saying: The square is divided on one side into 1 inch, ½ inch, ¼ inch, ⅛ inch, and on one side into $\frac{1}{16}$ inch, $\frac{1}{12}$ inch and $\frac{1}{32}$ inch. It has also a board measure stamped on one side of the blade, which can be easily understood, and will be often found quite useful. The more expensive ones will have a

diagonal scale at the junction of the blade and tongue, which will be found handy when you are wanting to take off hundredths of an inch; but for the every-day carpenter the ordinary subdivisions will be found sufficient. There will also be a diagonal scale on one side of the tongue; the two figures placed over each other represent the two sides of the square; the figures to the right the hypothenuse, or the exact length of a brace required to touch the measurements given.

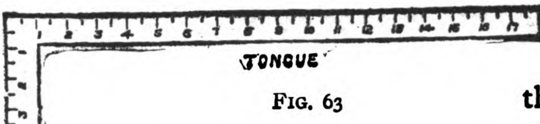



Fig. 63

Let us take a few examples of using the steel square and plainly show its uses and advantages.

We have to cut a brace to support a beam or bracket. (Fig. 63 shows the square.) We wish it to run to a point 16 inches from the inside of the beam and 21 inches down the post or jamb. We apply the square

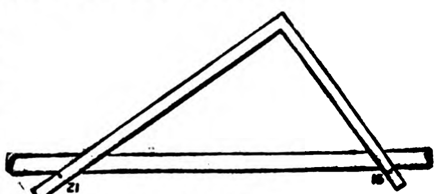


Fig. 64

thus (Fig. 64): Place the corresponding figures 21 on the blade and 16 on the tongue just touching the edge of the brace piece, mark by both blade and tongue and you have the length and bevels to fit. Fig. 65 shows the brace in position and the square laid on the angle. This shows the workman that the square simply represents the angle into which the brace has to fit. Now this rule follows likewise right through; you make the square represent the angle you have to fit. Sometimes you have a chance to place the brace in position and mark it.

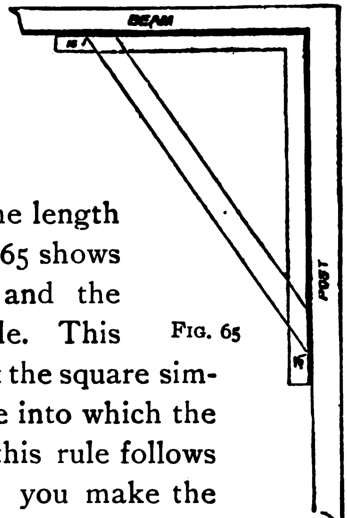


FIG. 65

We now have to fit a similar brace touching a point 2 feet 10 inches on the beam and 3 feet 8 inches down the post, with the ends toed-in ½ inch to prevent its slipping away. We now take 22 inches on the blade and 17 inches on the tongue and apply it to the brace piece as before, repeating the operation, as Fig. 66, which will give the proper

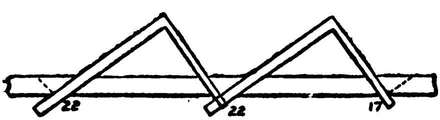


FIG. 66

length of the brace. Now square out from the bevel given and measure off on this line ½ inch, now draw line touching the inside edge of the first bevel, and you then have the desired cut.

Fig. 67 shows the brace in position and the square laid on, showing the manner the square is applied when the length is out of the scope of once applying the square and still not long enough to obtain correctly in the manner I am about to show in getting at the length of rafters, although the length and bevel of any rafter can be got in this manner by dividing the rise and run

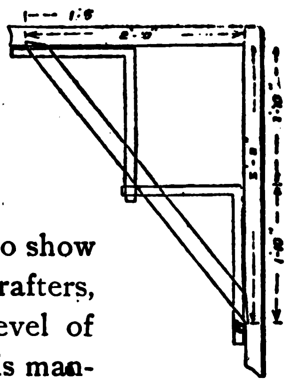


FIG. 67

by a number, viz., 10 feet run, 8 feet rise, divided by 6 equals 20 inches and 16 inches; apply square number of times as divisor 6. But great care must be taken to keep the square exactly on the mark made in the previous application, otherwise the rafter will be too long or too short, as the case may be. Therefore, I have always found the following method the best, besides being much quicker for obtaining the lengths and bevels of rafters. Our first roof will consist of rafters with a collar joist nailed across from

one to the other at the ceiling line to prevent sagging in the middle, and to act as ceiling joist at the same time. This building will be 22 feet wide, and as we have to consider only half the width, each set of rafters running to the center will be 11 feet, the rise will be 9 inches to the foot, or 8 feet 3 inches to top of ridge-pole.

We now consider the 1-inch divisions on the square as feet and the subdivisions twelfths or inches; we take a straight-edge, or any board with a nicely pointed edge and lay the square on same with the 11-inch mark on the blade and the $8\frac{3}{12}$ inch on the tongue coinciding with the edge of the board. Now take a fine pencil, or better still, a knife, and mark by these on edge of the board the distance between these points $13\frac{9}{12}$ inches, which equals 13 feet 9 inches, which is near enough for all practical purposes. Now take rafter piece, using the 11-inch and $8\frac{3}{12}$ inch marks, bevel at foot by the 11-inch mark, measure off 13 feet 9 inches. Now mark the cut at the ridge by the

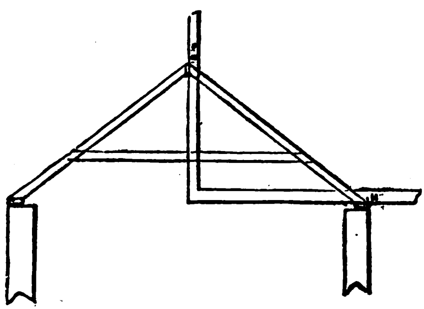


FIG. 68

$8\frac{3}{16}$-inch mark and measure back from this mark half the thickness of the ridge. This is length. Fig. 68 shows section of roof with the square laid on. To get the bevel of collar joist take the run on the blade 11 inches, and the rise on the tongue $8\frac{3}{16}$ inches. The blade gives the cut. Supposing the ends of the building have to be hipped in, to get the length and bevels of the hips, etc., proceed as follows:

The run of a hip rafter is the diagonal of half the width of building, so we take 11 inches on both blade and tongue and lay on the straight-edge. This gives us the run of the hip. We take this measurement on the blade and the

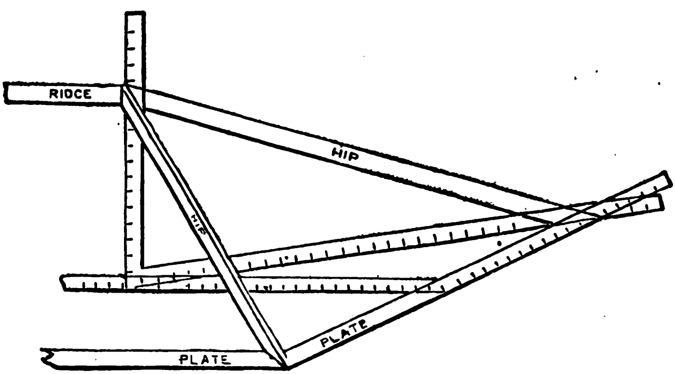


FIG. 69

rise $8\frac{3}{16}$ inches on the tongue. This gives us the proper length of hip, and these figures the ridge

and plate cuts. For the side bevel, to get the ridge-pole take the length of the hip on the blade and the run of same on the tongue; the blade gives the cut. Now as to the jack rafters, their lengths can be obtained in the following manner: Divide the length of the common rafter by the number of openings between the last common rafter and the corner of the building, and you have the length of the shortest jack, viz., placing the rafters 12 inches on centers you get eleven openings, so divide 13 feet 9 inches by 11 you get 1 foot 3 inches. The new jack will be twice this length, the third three times and so on. Lay off these measurements up the center of the back of jacks and deduct half the thickness. Hip: For the bevel to fit hip take the length in common rafters on the blade 13 feet 9 inches and its run 11 on the tongue; the blade gives the bevel.

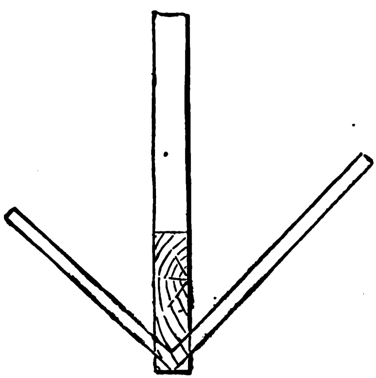


Fig. 70

To find the backing of hip take the length of hip on the blade and its rise on the tongue, the blade gives the bevel; or

lay the angle of the square on the foot of hip where it fits the plate, taking care that it is exactly true from each corner, mark by and transfer them up the sides and you have its correct bevel. (Figs. 69 and 70.)

Fig. 71 is a roof having three gables, each being a different pitch, the two valleys being unequal as regards run. The ridge is 8 feet above the level or plate. Proceed as follows: The rafters for the front

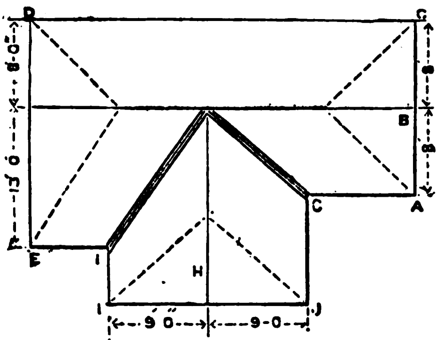


FIG. 71

side of left gable, E, we will consider first. Take the run 13 on the blade and 8 on the rise of the tongue, measure across with your 2-foot rule (or lay the square to a straight-edge) and you get 15¼, equal to 15 feet 3 inches, which is the length. Take 13 on the blade, 8 on the tongue; this gives the plumb and level cuts. All the other common rafters will be found in the same manner, viz., at AC and D take 8, and 8 at IJ, take 9 and 8 to get the valley F, take 13 inches on blade, the run of the

common rafter on left gable, 9 inches on the tongue, the run of common rafter on front gable, measure across and you have $15\frac{10}{12}$, which is, practically speaking, 15 feet 10 inches. This is the run. You now take this on the blade, and the rise, 8, on the tongue, measure across and you get 17¾, which we will call 17 feet 9 inches, the length of the valley. Deduct the diagonal of half the thickness of the ridge, e.g., if the ridge is 2 inches measure across from 1 to 1 on the square and deduct from the total length. The 15 feet 10 inches and the 8 gives the plumb and bevel cuts, the bevels to fit the ridge on the back of valley. Take the length of common rafter on front side, 15¼ on the blade, and the run of the common rafter on front gable, 9 feet, on the tongue, which is the distance it is carried to the right to strike the ridge H; the tongue gives the cut for main ridge, and the blade the cut for ridge H. Now as to the jack rafter on the front side of left gable, we divide the length of the common rafter, 15 feet 3 inches, by the number of openings, as previously shown, which gives us the length of the shortest jack, etc. The bevel across the back will be found by taking the length of common rafter, 15¼ inches, on the blade, and the run of the common rafter

on the opposite side of the valley, 9 inches, on the tongue. The blade gives the cut. The down bevel will be the same cut as the ordinary rafters at the ridge. The other jacks will be found in like manner for the other pitches. Hence the rule to find the bevel across the back of jack rafters when the whole of the roof is the same pitch. The length of common rafter on blade, its run on tongue; blade gives the bevel.

When the hip or valley runs between two different pitches take the length of the common rafter on the side you are working on the blade, and the run of the common rafter on the opposite side of the hip or valley on the tongue. Blade gives the cut. The same rule applies to valley as to hip, as a valley, properly speaking, is an inverted hip.

The main thing in framing a roof by the square is to understand the manner in which the square represents the building. But in looking at Fig. 68 you can see at a glance why it should give the correct length and bevels of an ordinary rafter. Likewise at Fig. 69 you make the blade of the square represent half the width of building and the tongue as well. If your hip runs the same from the end as it does from the side, take the diagonal of this on the blade, and the rise on

the tongue, and you have the length and bevels of it.

The whole thing boiled down presents itself in a very few simple facts, as any practical reader will acknowledge after reading carefully.

We now have a step-ladder to make to reach a landing 8 feet high, and to slope to a convenient point 4 feet 6 inches back. Now, as the square can be manipulated much easier when you are using figures some distance down the blade and tongue and also greater accuracy can be insured in marking a bevel, we take 16 on the blade, 9 on the tongue, and exact proportion to the above, e.g., the quantity doubled. Take your sides and lay the figures to the front edge. The 9 gives you the bevel at floor and bevel of treads. Supposing we give each step a rise of 8 inches. we shall need 11 in the flight, the landing making the necessary 12 inches. We mark floor bevel, and before moving the square make a mark on the side opposite the 8 inches on the blade, as that represents the perpendicular rise; we then repeat this operation eleven times, the last time drawing a line down after the blade; this gives the cut that fits to the landing joist or wall. (Fig. 72.)

It is advisable, when you are using the same

bevel or figures repeatedly, as in this case, to take a couple of thin strips, say 1½ inches by ⅝ inch, and about 2 feet 8 inches long, run

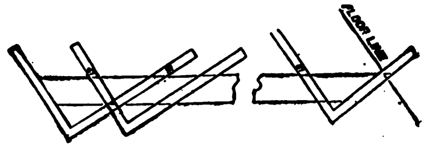


FIG. 72

in a screw about 4 inches from each end and insert the square between; set it to figures required and screw up together. You then have a guide which insures your using the same figures each time you apply it. A piece of stock, 1¾ inches by 1¼ inches, with a saw kerf run down about 1 foot from each end, is better still, with two screws to tighten. (Fig. 73.)

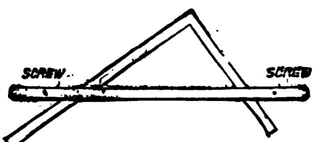


FIG. 73

There is no roofing bevel but what can be easily and expeditiously found with the steel square, amongst other things finding the bevel at the intersection of any form of polygon, miter and butt joint of hoppers, setting out staircases, finding the area of circles, the diameter being given, etc., and dozens of other problems in mathematics, geometry, etc. There are several books published, I believe, in America on this matter, and during my sojourn in that country I hardly ever saw a carpenter's "kit" that did not

include the square, and why the English carpenters are so slow in adopting it I cannot understand, as it is a *sine qua non* in solving nearly all imaginary difficulties."

SOME PRACTICAL EXAMPLES

My connection with a number of building and technical journals as editor and contributor has placed me in touch with a number of expert workmen who have made a specialty of studying the steel square and its uses, and these gentlemen have never been backward in permitting me to make use of such of their suggestions as I thought of sufficient importance to lay before my readers.

Among these I may mention D. L. Stoddard, Indianapolis, Ind.; Wm. E. Hill, Terre Haute, Ind., and many others, besides the gentlemen named in the preface of this volume, and the following practical examples are a few of those submitted to me, and which have appeared in print in various places. The greater number of these examples are the work of Messrs. Stoddard and Woods, and their good value will be appreciated after the reader has studied them awhile. Unlike other tools, it is not likely the square will ever go out of fashion, or be supplanted by any

other device, but will always be in quest so long as there are mechanics whose daily work requires them to make quick application of mathematical rules. It may be improved from time to time, and made so as to meet special wants better than now, but it is doubtful if much more can be done to it so as to make it more acceptable to the general workman. It has been used since the very beginning of the mechanical trades, and is likely to continue through all the ages.

It is the simplest of tools, and may be described as the mechanical embodiment of a right angle. It must necessarily have some breadth in order to give the tool necessary stability, and, therefore, as the embodiment of a right angle it is of a form to give us both the exterior and interior shape. The blade of the square is made a little wider than the tongue, more for convenience, I think, than for any other reason, for I have seen squares somewhat old, to be sure, and made long before the tools which are now in most common use were sent out from the factory, of which the blade and tongue were approximately of the same width.

The blade of the square, as commonly constructed, is 2 feet, or 24 inches long, and the

tongue somewhat less. I have seen squares of which the tongue and blade were of equal lengths, and also those, the blades of which were considerably longer than those of the square of present make, and still others of which the tongues were considerably shorter than is now the rule. But this is long ago. The most commonly accepted dimensions for a carpenter's square at the present time are, blade 24 inches long, tongue 18 inches long, blade 2 inches wide and tongue 1½ inches wide. This gives for inside measurements blade, 22½ inches and tongue 16 inches.

I have described the square as the embodiment of a right angle. If the square is not a right angle, or to use common terms, if the tool is "out of square," that is, if it is in the least inaccurate, its usefulness is destroyed. When the square is inaccurate instead of solving intricate geometrical problems correctly it becomes a snare and a delusion, leading to false results and misfits in general. It is somewhat remarkable how few workmen test their squares. I am disposed to believe from long experience that comparatively few mechanics who buy steel squares are cognizant of the possible defects that the tool may have and of the tests which

may be applied for the purpose of demonstrating its accuracy. Before proceeding further, therefore, in the discussion of the use of this instrument let us give brief attention to some of the simple methods that may be employed for determining the accuracy of the tool. By way of making practical application of these tests I suggest that at the next dinner hour the reader borrow from his fellow carpenters as many squares as may be convenient, and apply to them more or less of the tests which follow, merely for the purpose of practice, and at the same time to show to what extent the squares in use are correct.

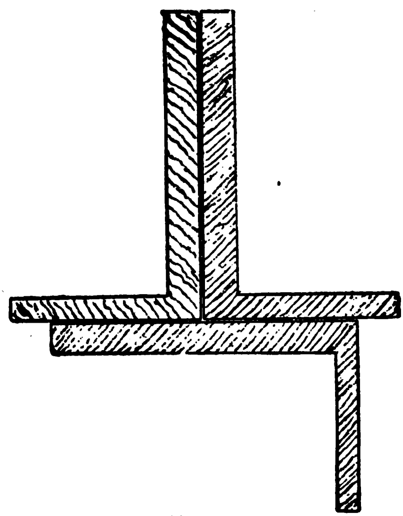


Fig. 74

Fig. 74 shows a very common method of testing the exterior angle of a steel square. Two squares are placed against each other and a straight-edge, or against the blade of a third square. If the edges of the

squares exactly coincide throughout the squares may be considered correct.

Suppose, however, that there is a discrepancy shown by this test, and that as the two squares are placed in the general position, shown in the illustration, they part at the heel, while touching at the ends of the blades, or touching at the heel that they part at the ends of the blades. This evidently shows that one of the squares is inaccurate, or possibly that both are inaccurate. How is the inaccuracy to be located? The two squares may be placed face to face, with the blades upward from an even surface, say the face of the third square or the jointed edge of a board, and so held that their heels, for example, shall coincide. Then glance at the edges of the blades. If they exactly coincide it would indicate that the error is evenly divided between the two squares, a very improbable occurrence. Compare the two squares in the reverse position, that is, with the tongues extending upward. Then apply the test shown in Fig. 75, and finally that shown in Fig. 76.

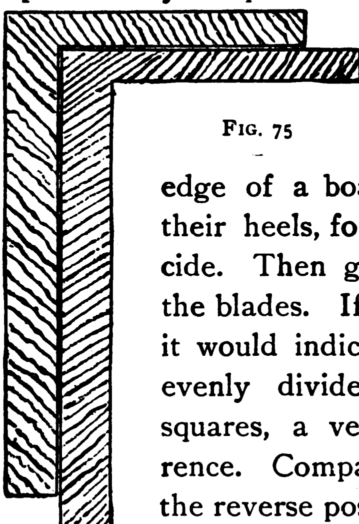


FIG. 75

By trying the squares one inside of the other, as shown in Fig. 75, the exterior angle is compared with the interior angle. If the edges throughout fit together tightly, first using one square inside and then the other, it is almost conclusive evidence that both the squares are accurate.

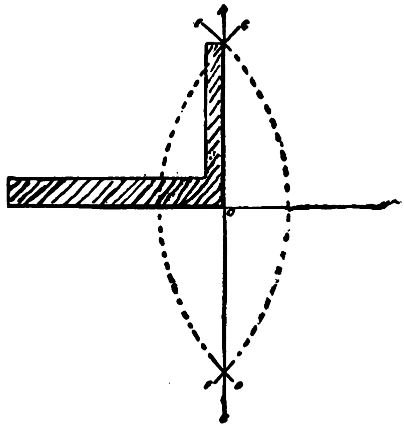


FIG. 76

By tests of the kinds just described among several squares, the mechanic will soon perceive from the several ascertained results that one or the other of the several squares that he is handling is more accurate than all the others, if not absolutely accurate. There still remains the need of a test, however, to prove the absolute accuracy of the particular square which he believes to be about right. On a drafting table, or a smooth board, let him next perform the following experiment, which is one of the several that might be mentioned in this connection: Draw a straight line, AB, say three feet

in length, as shown in Fig. 76. This may be done by a straight-edge. Use a hard pencil sharpened to a chisel point. With the compasses, using A and B as centers, and with a radius longer than one-half of AB strike the arcs CD and EF. Then with the straight-edge draw a straight line, GH, through the intersection of the arcs. If the work is accurately done the resulting angles AOH, HOB, BOG, and GOA will be right angles. Lay the square to be tested onto one of these angles, as shown in the illustration, and with a chisel-pointed pencil scribe along the blade and along the tongue. If the lines thus drawn exactly coincide with those first drawn it is satisfactory proof that the square is accurate, and in the same way the square may be placed against one or the other of these right angles in a way to test its interior angle.

The method shown in Fig. 76 anticipates the use of another tool besides the square in making the test. A right angle, however, may be drawn for the purpose described by a method which uses only the square, and which does not require the services of any other tool, or what is the same thing consider the tool itself to be the figure drawn, and then measure for the purpose of determining the accuracy of the figure.

Various writers have discussed the properties of the right-angled triangle, but we all know that a square erected on a hypothenuse of a right-angled triangle is equal to the sum of the squares erected on the base and perpendicular. This is a well-known mathematical truth, and it may be applied in the tests we are making. Those carpenters who have had occasion to lay out the foundations of houses are well acquainted with the old rule frequently known as "the 6, 8 and 10," which depends upon the relationship of the squares of the perpendicular and the base to the square of the hypothenuse. Thus the square of 6 is 36, the square of 8 is 64. The sum of 36 and 64 is 100. And the square of 10 is 100. Now let us make application of this rule to test the steel square.

For the sake of accuracy we want to take figures which are as large as possible, so as to reduce the possible error in measurement to the smallest possible dimensions. Let us take for dimensions 9, 12 and 15 inches. That these will serve is easily demonstrated. The square of 9 is 81. The square of 12 is 144. The sum of these squares is 225, and the square of 15 is 225. Therefore, if the tool that we are testing shows a dimension of exactly 15 inches measured from 9 on the outside of the tongue to 12 on the out-

side of the blade, as shown in Fig. 77, it will be proof that the square is correct.

It may be somewhat difficult to make a measurement of this kind on the instrument itself, with sufficient accuracy to be beyond dispute. I suggest, therefore, that the square be laid flat upon an even surface, like a drawing table, and that

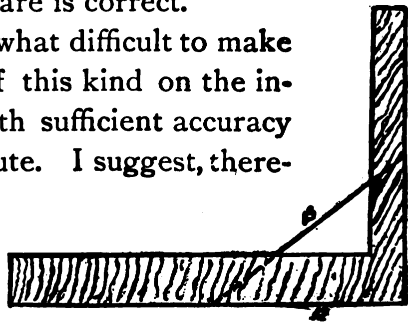


FIG. 77

with a chisel-pointed pencil lines be scribed along the tongue and along the blade. Mark accurately the distance of 9 inches from the heel up the tongue, and 12 inches from the heel along the blade. Then measure diagonally and see if the distance is exactly 15 inches.

In what has preceded there has been a suggestion that the error due to lack of precision in measurement is diminished if the figures are increased in size. If the size of the drafting table permits, therefore, extend the line drawn along the tongue of the square to 3 feet. Extend that drawn along the blade to 4 feet. In doing this care must be taken that the lines thus extended are fair to the tool under examination, for if they are not drawn in a way to

strictly coincide with the edges of the square then the test is of no avail. Then measure from the ends of these lines, that is, from a point 3 feet from the heel up the tongue to a point 4 feet from the heel along the blade. If this diagonal distance is exactly 5 feet it will show that the angle represented by the heel of the square, as I have described it, is a right angle, and that, therefore, the test is accurate.

Now let us next examine a little more carefully the relationship of the square to frequently required lines. It is a common thing among carpenters to use 12 of the blade and 12 of the tongue for a right angle or square miter. Why are these figures employed, or to put the question otherwise, how is it determined that 12 and 12 are the proper figures? Perhaps the question can be made still clearer by another illustration. It is common to say that 12 of the blade and 5 of the tongue is correct for the octagon miter. How is this determined? In Fig. 78 there is shown a quarter circle, XG, described from the center, C. Along the horizontal line, AB, the blade of the square is laid with 12 of the blade against the center C, from which the quadrant was struck. Now if we divide this quadrant into halves, thus establish-

ing the point E, and if from E we drawn a line

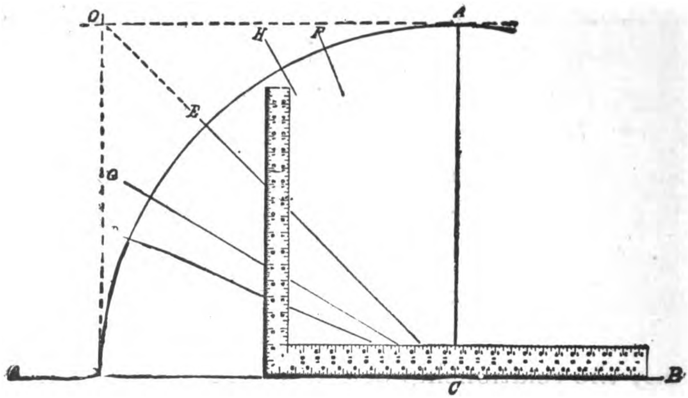


FIG. 78

to the center C, which is 12 of the blade, it will be found that it cuts also 12 of the tongue. If we complete the figure by erecting a perpendicular line from the point X, and intersecting it with a horizontal line from G, thus establishing the point O, it becomes very evident that CE is the miter line of a square.

If we bisect XE, thus establishing the point D, and by the conditions existing setting off in the quadrant a space equal to one-quarter of its extent, and if from D we draw a line to the center, C, corresponding, as already mentioned, with 12 on the blade, we shall find that this line (DC) cuts the tongue on the point 5 (very

nearly, the exact figures being $4\frac{31}{32}$ inches). The line DC, as above explained, bisects the eighth of a circle. In other words, it is the line for an octagon miter, and, therefore, we say that for an octagon miter we take 12 on the blade and 5 on the tongue.

By dividing the quadrant into three equal parts, as shown by XG, GH and HG, we obtain by drawing GC the line corresponding to the hexagon miter. This, it will be observed, cuts the tongue of the square at 7 (very nearly, the exact figures being $6\frac{15}{16}$ inches), and, therefore, we say for hexagon miters we take 12 of the blade and 7 of the tongue.

The question sometimes arises, can the square be employed to describe a circle? While the square may be used for describing a circle of any diameter, providing the capacity of the square is not exceeded, still those who attempt to perform the work will very likely conclude before they are through that other means are more satisfactory for regular use. The way to proceed is indicated in Fig. 79. Let it be required to describe a circle, the diameter of which is equal to ED. Drive pins or nails at these points and

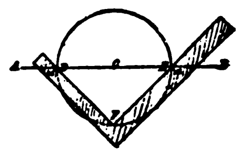


FIG. 79

place the square as shown in the sketch. Place a pencil in the interior angle of the square, as shown at F. Then gradually shift the square so that the pencil will move in the direction of D, always being careful to keep the inside of the blade and inside of the tongue in contact with the pins or nails, E, D. After having described the arc from F to D reverse the direction, describing the arc from F to E. Then turn the square over and by similar means complete the other half of the circle.

"There are still other methods of testing a square," says "Parallelogram" in *Carpenter*, from whose articles I have drawn freely, and I

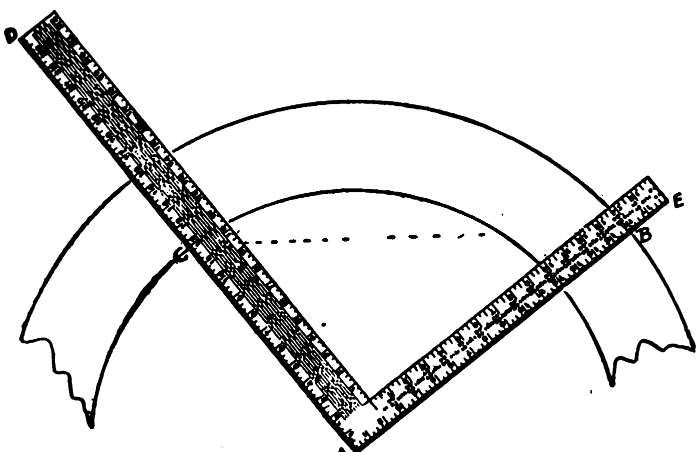


FIG. 80

propose submitting one here. "With an accurate right angle drawn upon a board or otherwise indicated, it is a comparatively simple matter to measure the square by it.

"Referring to Fig. 80 establish the center A at any convenient point. Then with the compasses set to 12 inches and to 16 inches respectively, strike the arcs as shown, producing them until they cover a little more than a quarter circle. Establish the point B wherever convenient on the outer arc, and with the compasses spread to 20 inches and one point in B cut the inner arc, thereby establishing the point C. Through A and B draw the line AE, as shown. Through A and C draw the line AD, as shown. Then DAE will be a right angle, and the square may be tested by laying it on as shown in the sketch."

The same results will be obtained if instead of using 12 and 16 for radii, as above described, we employ 6 and 8, and instead of using 20 for the distance from B to C we use 10. This may suggest to some of my readers that the rule here shown is only an application of that which is very commonly employed among builders in laying out foundations, and which is known as the old "rule of 6, 8 and 10." A little examina-

tion of the diagram will show that this supposi tion is entirely correct. The rule, as commonly described by carpenters, for squaring the corner of a building is something as follows: From the given corner measure along the line in one direction 6 feet, and in the other direction 8 feet. Then lay a pole across the angle and move one or the other of the lines until the diagonal measurement is exactly 10 feet. Of course this rule is based upon the principle that the hypothenuse of a right-angled triangle is equal to the square root of the sum of the squares of the two sides. Thus the square of 6 is 36, and the square of 8 is 64. The sum of the squares is 100, and the square root of 100 is 10.

Greater accuracy is secured by extending these measurements and taking larger numbers, which have the same relationship to each other. Therefore, in the diagram here shown we have taken 12, 16 and 20. It works out, however, just the same way. The square of 12 is 144, and the square of 16 is 256. The sum of these two squares is 400, and the square root of 400 is 20, which is the length of the hypothenuse. The method, however, that we have taken of drawing a diagram corresponding to these conditions is a little different from that which is usually

employed. We have taken two radii—12 and 1[illegible] inches respectively—and with them have struck portions of circles from a given center. Then we have measured from a fixed point in the larger of the two circles to a point in the smaller circle, a distance that is equal to the length of the required hypothenuse. Next we have drawn through these points respectively to the center, A, producing the lines DA and EA, as above mentioned. It is virtually the builders' rule for squaring a foundation worked backwards. It has certain advantages following upon the use of arcs of circles in place of the measuring pole.

It frequently happens in various kinds of work that carpenters require a right angle, the arms of which are very much longer than the squares with which their tool chests are provided. For example, they may want for a certain purpose a right-angled template, the arms of which are 6 to 8 feet in length. In building such a template it is much better to establish the angle by the method here described than to attempt to work by the ordinary tool.

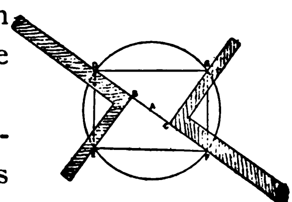


FIG. 81

In the other diagram presented herewith, Fig. 81, is shown a handy method for

determining the dimensions of the largest rectangle that can be drawn in a given circle. A practical application of the rule is to determine the dimensions of the largest timber other than square that could be cut from a given log. Through the center A of the circle draw any diameter, as DF. Divide this diameter into three equal parts, as shown by FC, CD and BD. Place the square as shown in the diagram with the blade against the diameter FD, and the heel against the point C. Draw the line CG, producing it until it cuts the circle at the point G. Reverse the square, as shown, and with the blade still against the diameter, and the heel brought to the point B draw the line BE, producing it until it cuts the circumference at E. Connect E, D and F, G. Also draw GD and FE. Then EDGF will be the dimension of the largest rectangle that can be drawn in the circle, or as above mentioned, the size of the largest stick of timber other than square that can be cut from the log represented by the circle.

The two diagrams, Figs. 82 and 83, when well understood will be found very useful and may be applied in hundreds of occasions in the daily routine of the workman.

Fig. 82 relates to roof pitches, and indicates

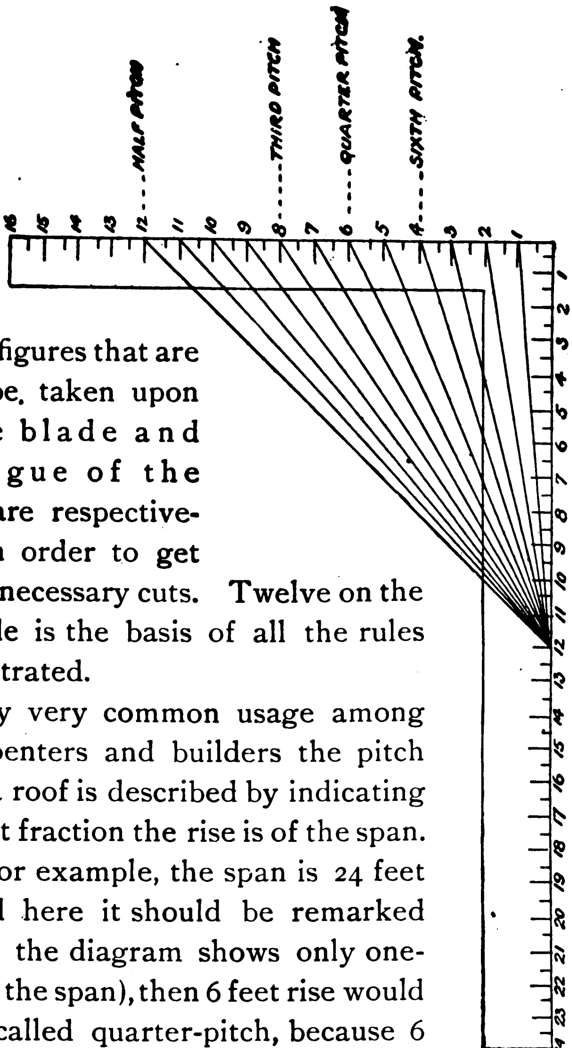


FIG. 82

the figures that are to be taken upon the blade and tongue of the square respectively in order to get the necessary cuts. Twelve on the blade is the basis of all the rules illustrated.

By very common usage among carpenters and builders the pitch of a roof is described by indicating what fraction the rise is of the span. If, for example, the span is 24 feet (and here it should be remarked that the diagram shows only one-half the span), then 6 feet rise would be called quarter-pitch, because 6 is one-quarter of 24. The rule,

somewhat arbitrarily expressed, that is applicable in such cases in roof framing, where the roof is one-quarter pitch, is as follows: Use 12 of the blade and 6 of the tongue. For other pitches use the figures appropriate thereto in the same general manner.

The diagram indicates the figures for sixth-pitch, quarter-pitch, third-pitch and half-pitch. The first three of these are in very common use, although the latter is somewhat exceptional.

It will take but a moment's reflection upon the part of a practical man, with this diagram before him, to perceive that no changes are necessary in the rule where the span is more or less than 24 feet. The cuts are the same for quarter-pitch, irrespective of the actual dimensions of the building. The square in all such cases is used on the basis of similar triangles. The broad rule is simply this: To construct with the square such a triangle as will proportionately and correctly represent the full size. The blade becomes the base, the tongue the altitude or rise, while the hypothenuse that results represents the rafter. The necessary cuts are shown by the tongue and blade respectively.

In Fig. 83 is indicated the relationship of certain divisions of the circle to different figures

on the square. Or to express it a little differ-

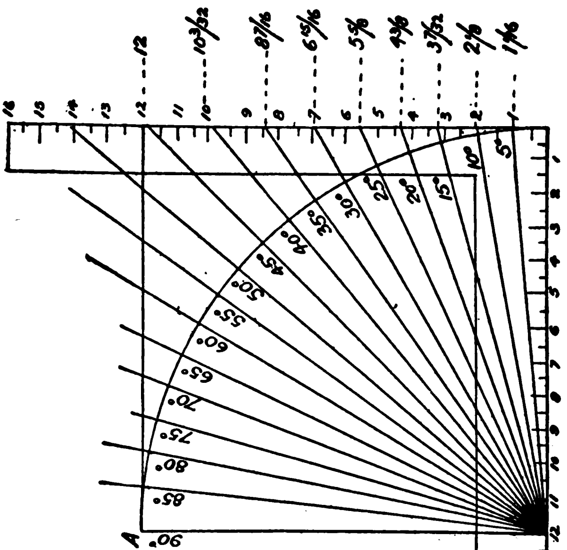


FIG. 82

ently, it shows how degrees may be obtained with the square. The divisions show the degrees from 5° to 90°, with the exact figures on the tongue necessary to produce the same. This diagram is also useful in roof work. For example, if a pitch of 25° is wanted, use 12 on the blade and 5⅝ on the tongue. By reversing the conditions 65 will be established.

In speaking of the square Mr. Stoddard says:

"The outside edge is divided into $\frac{1}{16}$ of an inch, the inside of the tongue divided into $\frac{1}{10}$, and the inside of blade $\frac{1}{32}$, while an inch on the face of the square in the corner is divided into $\frac{1}{100}$. The other side is divided into $\frac{1}{16}$ and 1/8. The great mass of figures on the face of the blade of the square is board measure. If you don't understand it you should learn at once, as it is very simple. If you have a board 14 feet long, look at 12 inches on the square. (That is where you always look for length of board.) Find 14, whatever the width of the board is move to that point. If it is 6 inches, the number of feet is 10 feet 6 inches. If a board is 10 feet long and 15 inches wide proceed the same as before, and you will find 12 feet 6 inches, and so on. If the board is 16 feet, simply double the result of 8, etc.

"The figures on the tongue are 'brace measure.' You will notice between the figures of 2 and 3 inches $\frac{18}{24}$30. It means if a brace runs 18 inches and rises 24 (or 2 feet) the length is 30 inches; or apply the square as in Fig. 84 and you will have the length and cuts.

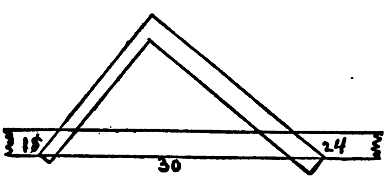


Fig. 84

"If the brace runs 3 feet each way, or 36 inches, you will find the length is 50.91 inches. But I don't use the brace measurements very much, as I prefer to apply square as in Fig. 85. If the brace runs 3 feet apply the square on 1 foot three times, etc.

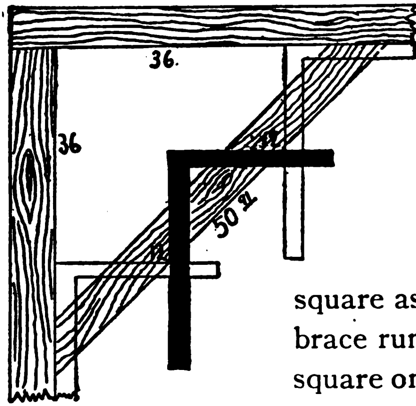


FIG. 85

"The figures on the opposite side of square are for laying off an octagon, and are used in this manner: Make a center line in your timber, and from that line measure the distance on your square to the figure representing the width of your timber; that gives corner of octagon."

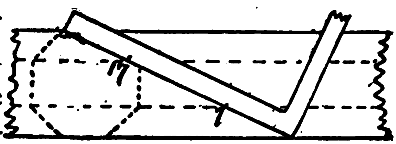


FIG. 86

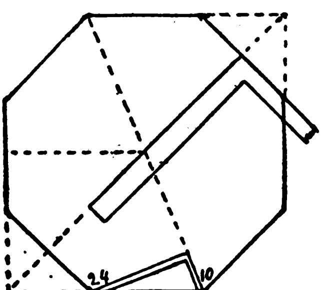


FIG. 87

Fig. 86 illustrates a much easier method. Lay your square diagonally across your timber and mark at 7 and 17, which

gives corner of octagon, 17 and $6\frac{15}{16}$ makes the correct line.

Fig. 87 shows how to lay off an octagon on the end of a timber. Lay the square on a line drawn from corner to corner, a distance equal to half the width of timber, square over, and you have one corner. Turn the square over and you have another, etc. The little square at bottom illustrates the octagon miter, which is 10 and 24; cut on 10. The octagon corner is a square miter. That is, if you cut timbers to lap at octagon corner they are cut on 12 and 12, or square miter.

If you should wish to miter a pentagon (5 sides) place the square on 9 and 12; cut on 9.

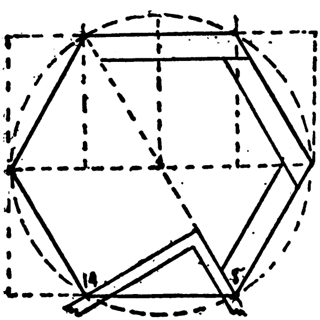


Fig. 88

Fig. 88 illustrates a hexagon. To lay off from a square timber divide two opposite sides into four equal parts, and the other two sides into two equal parts. A circle can be laid off into a hexagon the same way, as I think you can plainly understand from the illustration. The hexagon miter is 8 and 14, cut on 8. The corner is the same.

Fig. 89 illustrates laying off a stair, and needs no further explanation, as the method appears in a previous page.

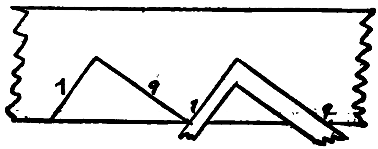


FIG. 89

Fig. 90 is an illustration of a good method of cutting bridging. If the joists are 8 inches wide and 16 inches centers, there will be 14 inches between. Place the square on 8 and 14, and cut on 8, and you have it. The only point to observe is that 8 is on the lower side of the piece of bridging while the 14 is on the upper, and not both on same side of timber, as in nearly all work.

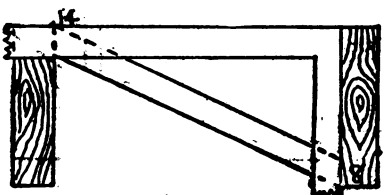


FIG. 90

Fig. 91 shows how to find center of circle with the square. I think the illustration explains all.

Fig. 92 shows a rapid method of dividing anything into several equal parts. If a board is 10½ inches wide, throw the

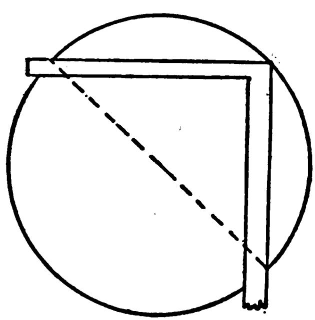


FIG. 91

square around to 12 and mark 3, 6 and 9, and you have it divided into four equal parts.

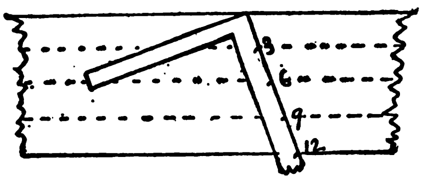


FIG. 92

Fig. 93 you may not come in contact with every day in carpentry work, but you would in photography.

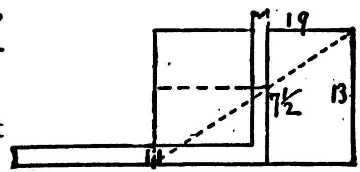


FIG. 93

If you have an object 13 inches by 18 inches, and you wish to reduce it to 11 inches long, how wide would it be? Draw a line from corner to corner; place the blade on 11, and where the tongue strikes the diagonal line is the width, or 7½ inches.

It is simply a problem of proportion worked out with a square, and you will find the square a rapid calculator.

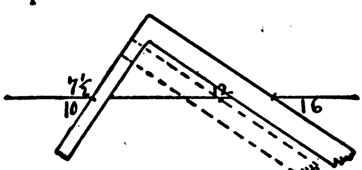


FIG. 94

Fig. 94 is another example of proportion. If 1,000 feet of lumber cost $16.00, 750 feet cost $12.00. As the illustration shows, with a little study you can apply the square instantly in a way to give

an accurate answer to problems that would otherwise take a long time, with many figures to figure out, and be liable to make mistakes besides.

Most of the foregoing examples are kindly furnished me by Mr. Stoddard, and while a number of them are similar to examples shown in previous pages, yet they offer to the reader different renderings of the same problems, and I have thought it proper to present them to the reader in the popular form given. Most workmen understand the plain language in which these examples and definitions are rendered, and it is the ardent desire of the writer and compiler of this work that its contents and diagrams be made as plain as pencil and the English language can make them, and to this end such material as that furnished by Messrs. Woods, Stoddard and others is gladly embodied in the book, as these gentlemen are past-masters in the art of handling the steel square.

The example shown at Fig. 90 for cutting in bridging is the invention of a president of a carpenter's union, and is employed by many workmen for marking off and cutting in bridging. It has many advantages over the old framer's method of striking two chalk lines across the edges of joists, and is more scientific.

The following examples and explanations on roof framing are simple and easily understood, and cannot fail of being valuable to the young mechanic who aspires to become an expert roof framer. These examples will serve as starters, and in the following volume, which will be issued shortly, more advanced examples will be presented.

ROOF FRAMING

Roof framing can be done about as many different ways as there are mechanics. But undoubtedly the easiest, most rapid and most practical is framing with the "square." The following cuts will illustrate several applications of the square as applied to roof framing, and all who are interested in the subject can, by giving it a careful study, be able to frame any ordinary roof the mechanic comes in contact with.

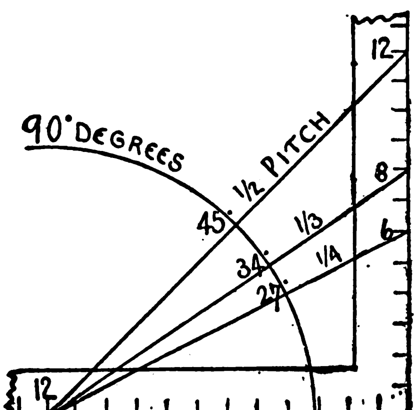


FIG. 95

Fig. 95 is an illustration that could well be

given much thought and study. It not only gives the most common pitches, but also gives the degrees.

Most carpenters know that half-pitch is 45 degrees, yet few know third-pitch is nearly 34, and quarter-pitch about 27 degrees.

A building 24 feet wide (as the rafters come to the center) has a 12-foot run and half-pitch, the rise would also be 12 feet, and the length of the rafter would be 17 feet (the diagonal of 12). Length, cuts, etc., could all be figured from the one illustration.

Fig. 96 illustrates a way to cut rafters with the square.

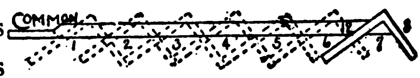


FIG. 96

A roof 14 feet wide would have a run of 7 feet, third-pitch would rise 8 inches to every foot run. Therefore, place the square on 8 and 12 seven times, and you have length and cuts.

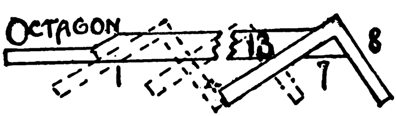


FIG. 97

Fig. 97. For the octagon rafter, proceed same as common rafter, only use 13 for run (in place of 12 for common rafter).

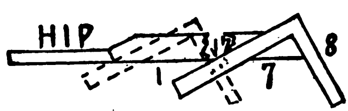


FIG. 98

Fig. 98, hip or val-

ley rafter. As these rafters run diagonal with the common rafter and as the diagonal of 1 foot is practically 17 inches, use 17 for run, and proceed same as common rafter.

Length of jacks. If there are to be five, divide the common rafter into six equal parts, use that for a pattern, and it gives the length very nicely. But that will not always work. To get all the different lengths might at first look difficult even to many good mechanics, but it is very

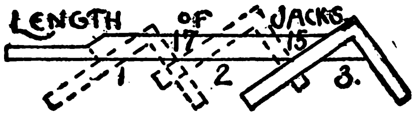


FIG. 99

simple as illustrated in Fig. 99. If the first jack was one foot from corner apply the square same as for common rafter, and it gives length and cut (mark the length for starting point on next), and if it is 17 inches from the other move the square up to 17, if the next is 15 move up to 15 and so on.

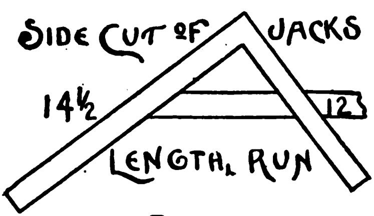


FIG. 100

Fig. 100. The side cut of jack to fit hip, if laid down level would, of course, be square miter, but the more the hip rises the sharper the angle. Meas-

ure across the square from 8 to 12, and it is nearly 14½, which is the length of rafter to one foot of run. Length and run, cut on length, gives the cut.

Fig. 101, octagon jack. As the octagon miter on level surface is 5 and 12, it must raise same as common jack, and is, therefore, raised to length, or 14½, and 5 cut on length.

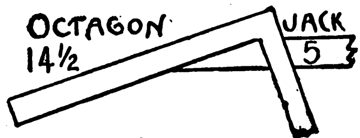


FIG. 101

Fig. 102, hip rafter, is also length and run, cut on length.

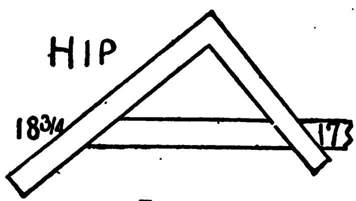


FIG. 102

Fig. 103. To bevel top of hip take length and rise and mark on rise.

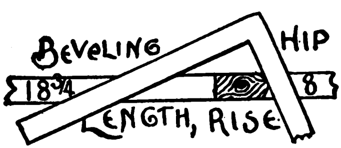


FIG. 103

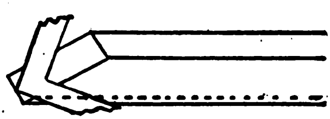


FIG. 104

Fig. 104 is another practical way, which is simply to lay the square on heel or hip. The illustration explains itself.

Perhaps the most practical way of all to frame a roof, the simplest to understand. easiest to

remember, and most rapid to apply is simply to always take the rise and run, measure across the square which gives length. Rise and run gives cuts, so you have it all.

Fig. 105 illustrates a roof 25 feet wide and a rise 10 feet 9 inches, run 12 feet 6 inches. Measuring across the square from 10¾ to 12½ gives 16½, or, 16 feet 6 inches is the length of rafter.

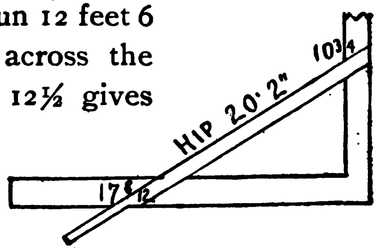


Fig. 105

Fig. 106. If the run of common rafter is 12½, the run of the hip will be diagonal of 12½, which is $17\frac{8}{12}$, as is plainly illustrated.

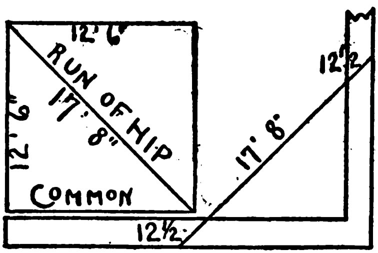


Fig. 106

Fig. 107. As the rise is 10¾ and run $17\frac{8}{12}$, the length will be 20 feet 2 inches.

Fig. 108. When a roof must go to a certain height to strike another building at a given point, as in additions, porches, etc., don't forget in getting the rise from

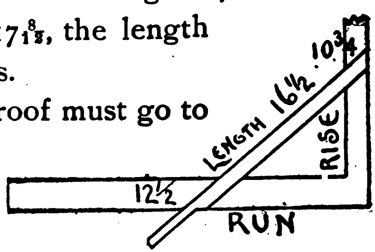


Fig. 107

plate to given point to allow the squaring up of heel as illustrated; and also remember to allow for ridge whenever one is used.

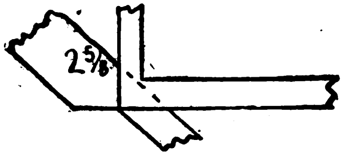


FIG. 108

Fig. 109 illustrates the cut of top of quarter-pitch rafter to lay on top of roof just mentioned. To apply the square first lay it on 12 and 6, which is quarter-pitch, and gives plumb-cut. From plumb-cut lay off pitch of main roof 10¾ and 12½, which gives cut.

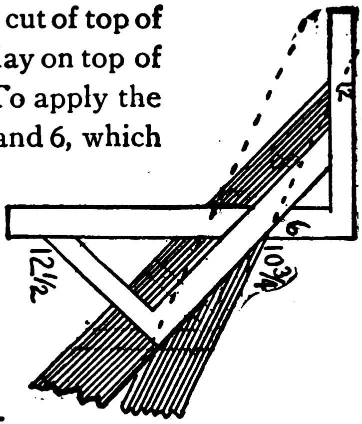


FIG. 109

Anyone that has studied this with a determination will have no trouble in framing any ordinary roof, as the general principles apply to all roofs, pitches, etc. So I will not take up any more space with roof framing at this time, but remember all sheathing, studding, cornice, etc., are made on the same cuts. In fact a hopper is also exactly on the same principle.

MISCELLANEOUS RULES

To make an ellipse for a three-foot opening, one foot high, drive a brad in a lath 1 foot from end, which gives height; another 18 inches from end, which gives one-half width; apply as illus-

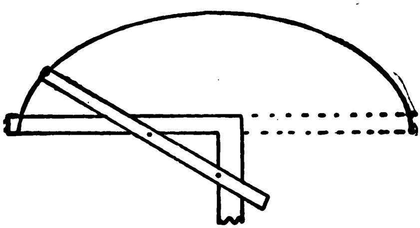


Fig. 110

trated in Fig. 110, reverse the square and it is completed.

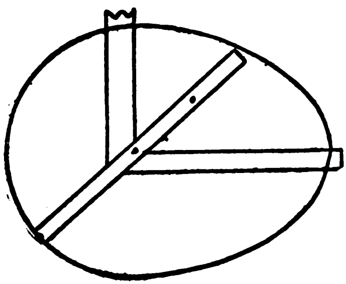


Fig. 111

Fig. 111. To make an oval, begin same as on ellipse, swing around on the one brad, which will make a circle at the large end, and it is formed as illustrated.

Fig. 112. To bend a board for a circle, if the

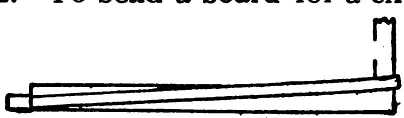


Fig. 112

given length is two feet, saw in and bend the board up until the joint is closed. If the saw is

very coarse it will raise at end about 2 inches. Therefore, saw in every 2 inches.

Fig. 113. To find the number of courses of shingles for a roof. If they were 4 inches to the weather it would be three to the foot, and very easy. Therefore, to get any number practically as easy, is the point. If

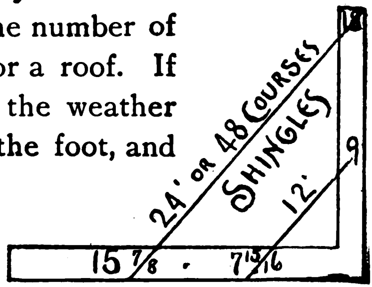


Fig. 113

4½ inches, two courses would be 9 inches. To get one foot length and only 9 inches actual measurement place one end of a foot at 9, swing around until the other end of the foot strikes the square, which is at $7\frac{15}{16}$. If the roof is 18 feet, measure from 18 parallel with the line just made, and it strikes the square at 15⅞, and the line from 18 to 15⅞ is 24; two courses to every foot diagonal measurement gives 48 courses. This may seem a little complicated at first, but when it is fully understood it can be applied instantly. Any numbers can be applied the same way.

Indeed it is impossible to say what cannot be done with the square, as I will show in Volume II how it may be employed as a calculating machine of considerable power.

In order that the reader may better under-

stand the handling of the square for laying out braces and simple roofs, I submit the following, which is somewhat different in application than some of the foregoing rules, though on the same principle. For example, if you wish to frame a brace for 4-foot run you lay the stick, or piece of timber, with straightest edge toward you. Taking the square at 12 inches on blade and 12 inches on the tongue, lay it on the stick, making a mark along the edge at the 12-inch mark on the square. Lay it on along the stick four times, which will give you the exact length between shoulders. The tenons must be added. Perhaps I can make it more satisfactory by giving a rough diagram. Let AB, in Fig. 114, represent timber for the brace. Lay the square on four times, as indicated, which will give you the exact length of

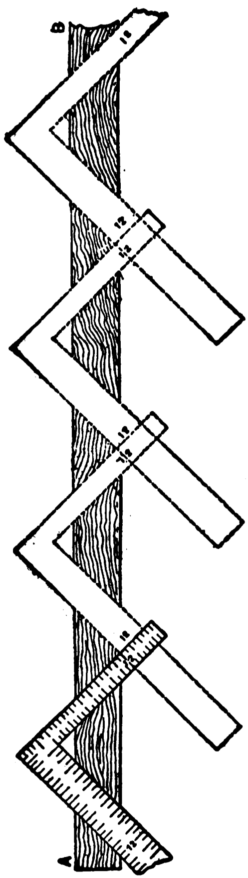


FIG. 114

a square of 4-foot rise and run. All square run braces may be made in same manner. For 3-foot run lay on three times, 5-foot run five times, 6-foot run six times, and so on.

In Fig. 115 the method of finding length of brace with 4-foot run and 6-foot rise is illustrated. You will notice the square is laid on at 12 and 8. It is to be repeated six times, as I have explained in connection with the other figure. The blade will give the bevel for one end, the tongue for the other. In all square runs the bevel is the same at both ends. By same method, also, you can find the length of all kinds of rafters.

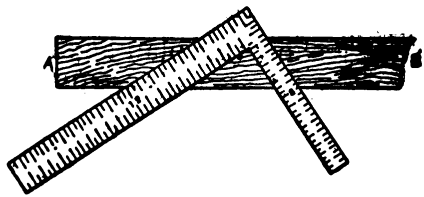


FIG. 115

In making a "draft," or drawing, for finding bevels and angles for braces or odd-shaped roofs, where angles are intended to be laid out with the square, it is best to make a scale of one-twelfth full size, which is most convenient in the use of the square for any purpose. By this scale each inch of the square represents a foot full size, and each twelfth of an inch of the square an inch full size. By using the square then as a scale, and reading measurements

made upon it as feet and inches, instead of inches and twelfths of inches, lengths of braces, etc., are very readily ascertained.

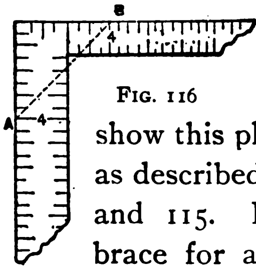


FIG. 116

This is practically illustrated in Figs. 116 and 117 of the accompanying sketches, which show this plan applied to the same braces as described and illustrated in Figs. 114 and 115. In Fig. 116, for obtaining a brace for a 4-foot run and a 4-foot rise set off 4 inches from the heel of the square along each arm, as shown by the points A and B. Then with another square or the pocket-rule measure between the points across the angle of the square, as shown by the dotted line. Note the distance from A to B in inches and twelfths of an inch, and read it feet and inches, which will be the length of the brace between shoulders. The tenons must be added.

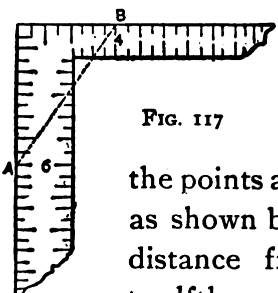


FIG. 117

The operation for a 6-foot rise and 4-foot run is illustrated in Fig. 117. Set off 6 inches for the rise, as shown by A, and 4 inches for the run, as shown by B. Take the distance from A to B, which read in feet and inches as before explained.

The bevels for the ends of the brace are to be obtained in the same general manner as described, by applying the square direct to the timber. In the last example it will be noticed that the proportion of 6 to 4 and 12 to 8 is the same, so that so far as concerns the bevel it is immaterial which figures are used in placing the square. 18 and 12 and 24 and 16 will also give the same bevel.

If it is desired to cut a miter box by aid of the square for raking mouldings, it can be done as follows: Draw the square, ABDC, Fig. 118, and lay off CF to the same pitch as the roof. From C as center, with CF as radius, describe the arc FE. Connect A and E. Then will the bevel at A be the cut across the top of box, and the bevel at F for side of box. The dotted lines of this figure represent the box or plan as may be. It will readily be seen that the results are correct, as GD is equal to DH, and DF shows the gain of the rafter.

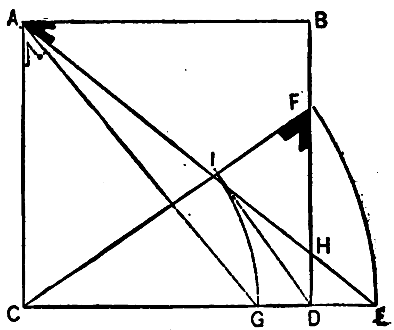


FIG. 118

Many carpenters cannot understand why it is

that if 12 and 12 on the square, when laid down on a line, make an angle of 45° on the lines of either blade or tongue, why 6 and 12, when laid down on the same line, do not make a miter for an octagon. The reason why 12 and 6 will not give the cut for an octagon (20° 30′), when 12 and 12 give a cut for miter (45°), is because the tangent of 22° 30′, the radius being 12, equals 4.97052, whereas the tangent of 45° equals 12. I will give the following rule for determining the cuts by the

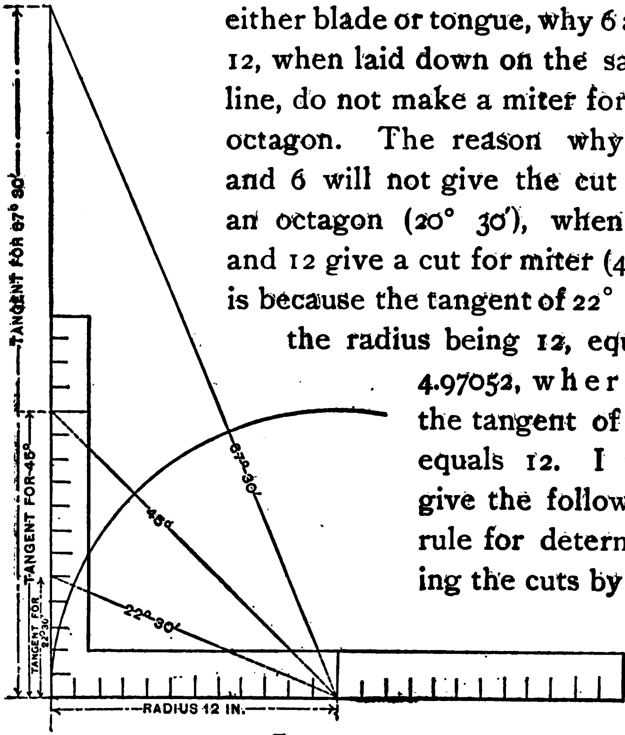


FIG. 119

steel square for any acute angle: Take any length on the blade as radius, then the length on the tongue will equal the tangent of the required angle. The accompanying diagram, Fig. 119, illustrates the principle.

A few examples furnished me by Mr. A. W.

Woods, and which are out of the general line, are presented at this point to illustrate some of the possibilities of the steel square. An opening for a round pipe in a pitched roof or partition at any angle may be found as shown in Fig. 120. Here we have a 6-inch pipe intersecting a two-thirds pitch. A line from 12 to 16 on the square represents the pitch. Now with 12 as center and with radius equal to one-half of the diameter of the pipe draw a circle and square up from the tongue to the pitch, as shown at BC. Then AB represents one-half of the short diameter, and AC one-half of the long diameter. Now to make our illustration more clear we will transfer these lengths to a line at right angles with the tongue, crossing at 12.

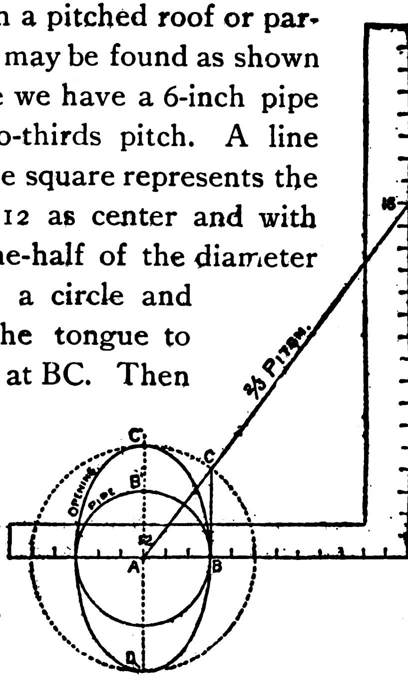


FIG. 120

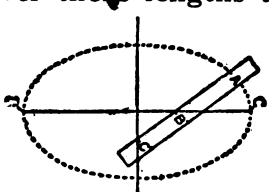


FIG. 121

There are several ways of finding the corresponding opening. Probably as good a method as any is that

shown in Fig. 121, which is as follows: Take a straight-edge, and on it space off A, B′, C′, as shown in Fig. 120.

Now draw a line equal to the long diameter, CD, and bisect it at right angles, and to these lines apply the straight-edge, as shown in Fig. 121. Always keeping BC on the lines and marking at A will describe the required opening.

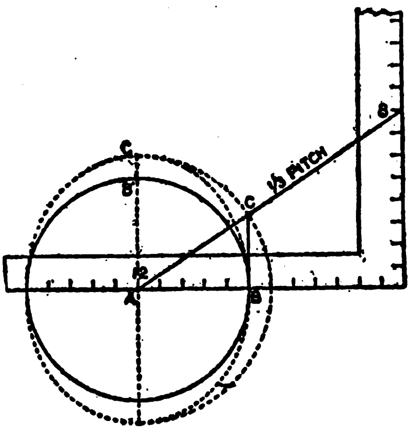


Fig. 122

The steeper the pitch the longer will be the required opening. In Fig. 122 is shown the same formula, but with the one-third pitch and a 10-inch pipe. Fig. 123 shows another method of obtaining the opening, and is as follows: Lay off the run,

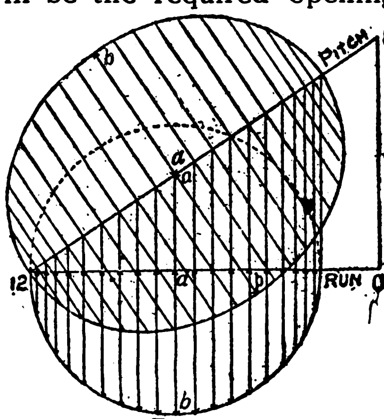


Fig. 123

rise and pitch, and with one-half the diameter of the pipe as radius, with the pencil point resting at 12, and center on the run, draw a semicircle. Divide the diameter into any number of spaces and through these, run lines at right angles with the run from the circle to the pitch. At point of intersection on the pitch draw lines on either side at right angles and on this measure equal the length of the corresponding lines of the semi-circle, as at AB. Run an off-hand curve, touching these points, will give the required opening.

Suppose we wish to cut in two cross braces in a timber construction, such as a barn, or a bridge, or similar work as shown in the sketch Fig. 124, we will make the dotted line F represent the distance apart on centers of the tops or feet of the braces, and B the perpendicular run. Let *t* and *b* be taken on the tongue and blade of the square respectively according to scale. Take the cut of *t* for the top or the foot of the braces. The diagonal distance from *t* to *b* is the length according to scale. For the cross cuts mark along *b* and extend the line thus made. Again, apply *t* and *b* to this line, and mark along *b*, which will be the cut required, as shown at C. We may say that the reference letters are

intended to represent actual and proportionate measurements; actual when applied to runs and

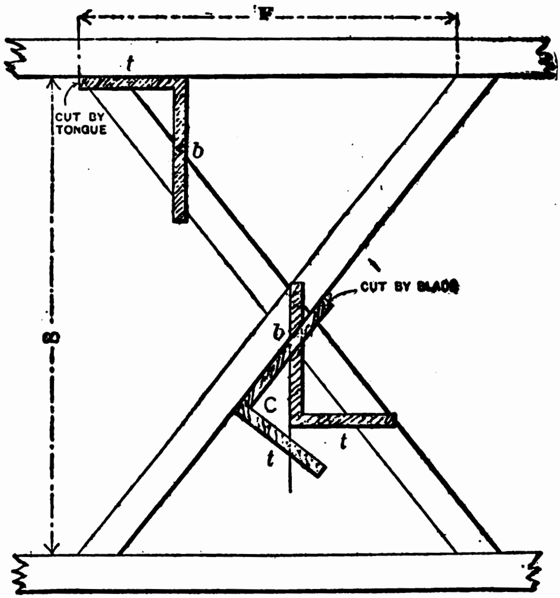


FIG. 124

other measurements of braces, and proportionate when applied to optional scale measurements by the steel square. The letters *t* and *b* are used because they are the initials of tongue and blade, and consequently suggestive. The principle is general, and applies to all similar cross braces of rectangular frames.

Another method for a single post is shown at Fig. 125, where the brace or leaning post is

tenoned into sill and girt. First lay out the lower tenon, then measure along from that point 12 feet to the shoulder of the next bearing, laying out the intervening connections and squaring across always from the outer corner or angle if it is a "sawed," or from the "line" if it is a "hewn" timber. Now, a leaning brace of the kind in point is nothing more than

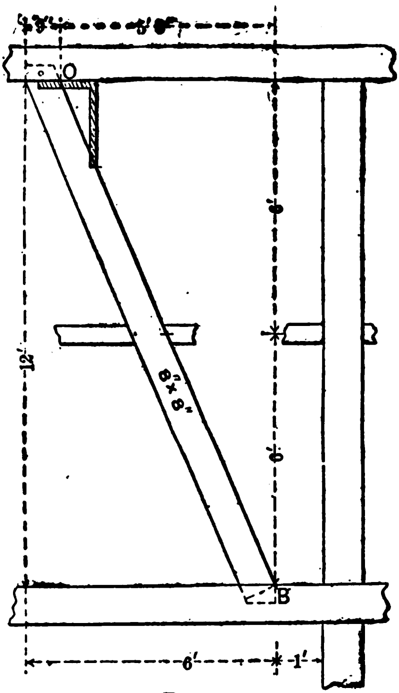


FIG. 125

a leaning post, and in this case the post leans 5 feet 3 inches from the perpendicular. So in the same way lay out, not from "toe to toe," but from "toe to heel," or on the line BO. In practice it is always best to lay out the mortises for the leaning braces in the parallel timbers with the run from "center to center," which is the same as from "toe to heel."

According to the foregoing argument, then, the run is not 6 feet, but 5 feet 3 inches. And we proceed to lay off the brace, using 24 inches on the long and 10½ inches on the short blade of the square, and applying to the corner of the timber, or to the "line" parallel with it as the case may be. Either B or O may be used as a starting point, the result will be the same.

This example is, of course, for one particular case, but it will give the reader a suggestion of how he may deal with all cases when there are leaning posts or braces of irregular runs and rise. I will deal with this subject at some length in the succeeding volume.

Carpenters, as a rule, do not thoroughly understand how to miter fascia and crown mouldings in cornicing hip and valley roofs. I will now present a problem in mitering, which is frequently met with in the usual practice of building. Fig. 126 represents the plan of a hip and valley roof, the main part being a plain gable roof, and the wing part is hipped, forming two hips and two valleys, as shown in the sketch. We will suppose that the ends of the rafters are to be cut square with the roof, which is one of the most common methods of putting up cornice.

There is nothing bothersome about the joints except in the valleys and on the hip corners.

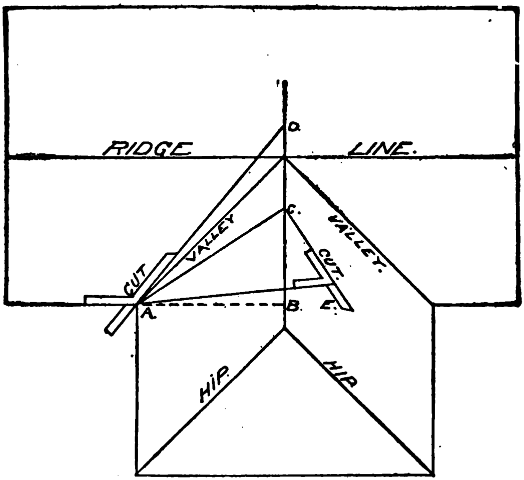


FIG. 126

With these joints there is a double bevel to the miter, which seems to lead a good many mechanics to resort to the old cut and try rule. The proper bevel to cut may be readily found from the diagram, Fig. 126. After drawing the hip and valley lines and ridge lines, showing the plan of roof, set off the run of common rafter, as shown by dotted line, AB. Square up the rise of common rafter, as BC, and connect A and C for length of common rafter. Take the length of common rafter just found and set it off from B to D, connect A and D. For length and position

of valley rafter for finding the bevel across the edge of fascia, set the bevel with the stock on the plate line and the blade on the line AD. The blade gives the cut as shown in sketch. Next square down from C the rise of common rafter, as CE, and connect A, E, which completes the lines for finding the bevel across the face of fascia board. Set the bevel with stock on line AE and blade on CE; blade gives the cut. The diagram shows the bevels for cutting the fascia and mouldings. Do not confound them with the bevels for cutting the rafters, for they are entirely different, and it would be an exceptional case if they were ever found to be the same.

I will now show, by means of the steel square, how to determine the proper figures to use for making the cuts. We will take a third-pitch roof for example. As a third-pitch roof is indicated by 12 inches run and 8 inches rise, we will take 12 inches on the blade of the square and 8 inches on the tongue, as shown in Fig. 127. Draw the diagonal, which will represent the length

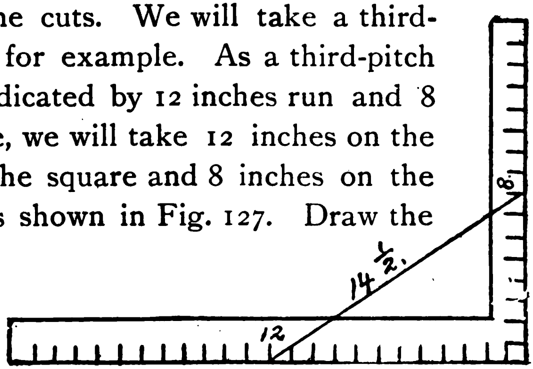


FIG. 127

of common rafter to the foot run of the given pitch, and which is very nearly 14½ inches. This is near enough for all practical purposes. We now have all the figures, which, if properly applied on the blade and tongue of a square, will give all the cuts. Take 12 on the blade and 14½ on the tongue, and the blade gives cut for edge of fascia. Take 14½ on blade and 8 on the tongue, and tongue gives cut for side or face of fascia.

Mouldings cannot very well be cut without a

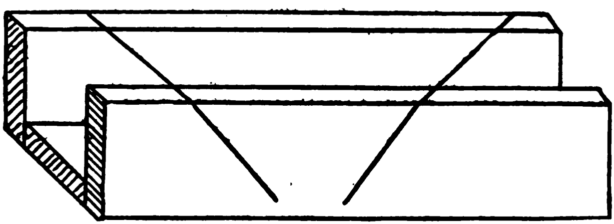


FIG. 128

miter box. Fig. 128 represents the manner of making the box with the cuts as described, by the square. Lay the square on top of box corresponding to the figures 12 and 14½ and scribe on the 12-inch side for the cut across the top of box. Reverse the square and scribe on the 12-inch side as before. This is necessary in order to obtain a right and left cut in the box. For the cut down the sides of the box lay the

square on corresponding to the figures 14½ and 8. Scribe and cut on the 8-inch side. Reverse the square as before, so as to complete both the right and left-hand cuts across the top of box and down the sides.

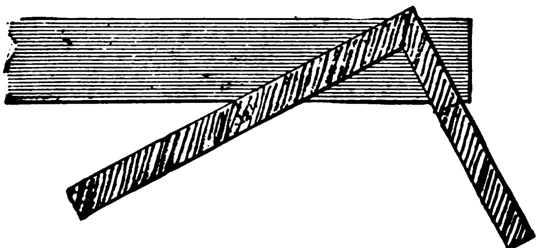


Fig. 129

The foregoing is largely taken from a paper published in "The National Builder," by J. P. Hicks, of Omaha, and while not altogether new

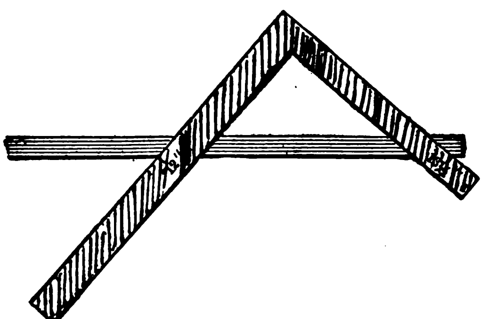


Fig. 130

is very ingeniously presented. Following somewhat on the same lines the illustrations shown at Figs. 129, 130 and 131 give another method of

cutting the members of a raking cornice where the angle is 45°. Suppose, for example, the roof is quarter-pitch, it is necessary first to cut the level freize as if it were going square across the end of the building; then take the raking frieze and lay the square on

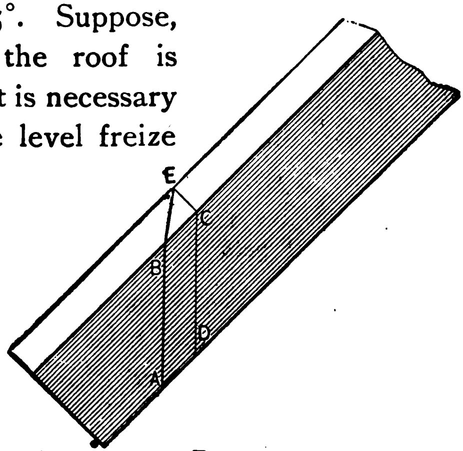


FIG. 131

the face of the board with the 6-inch mark on the tongue and the 12-inch mark on the blade, as shown in Fig. 129. Mark along the tongue to obtain the plumb-cut. In order to obtain the miter, measure across the square from the 6-inch mark to the 12-inch mark, which gives us very nearly 13½ inches. Now lay the square across the edge of the board, as shown in Fig. 130, with the 13½-inch mark on the tongue and the 12-inch mark on the blade; the tongue will give the bevel.

The rule is to take the rise per foot on the tongue of the square, and 12 inches on the blade and measure across these two marks, whatever

the distance may be, using it with 12 inches to obtain the miter, and mark by the long bevel. The same results may be obtained as follows: Cut one level frieze 45 degrees, or square miter; mark the plumb-cut on raking frieze where desired. In order to obtain the miter cut use the figures on the blade of the square, which corresponds with the length of the common rafter, and on the tongue those which represent the run of the rafter; cut by the blade. Some carpenters mark the plumb-cut AB, as shown in the sketch, Fig. 131, which I show, then draw the line CD parallel. The distance between the lines is equal to the thickness of the frieze. Square across the edge, CE, and draw the line from the first plumb-line to the square line on the other edge, as BE, which gives the cut as shown.

To find a line forming equal angles with two converging lines, AB and CD, Fig. 132, draw ED and BF parallel, and equally distant from AB and CD, intersecting each other at the point S; from the point S as center describe an arc, cutting the converging lines at the points P and R, which joined, give the line required.

The same can be found by the use of the square. Place, as shown, the square on the lines

AB and CD; mark from the point of intersection S, cutting the lines AB and CD at the

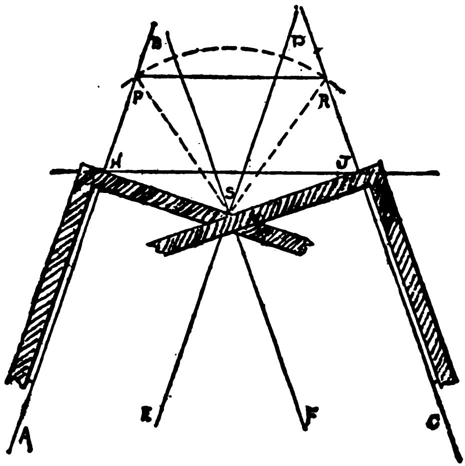


FIG. 132

points H and J, which joined give the line required.

The following very useful solutions were furnished me by Mr. A. W. Woods, architect, along with a number of others, which will be published in Volume II.

In some sections of the country with many framers, the rise is reckoned by the degree instead of a rise in proportion to the span. The rules in the application of the square for the cuts and bevels remaining the same, but in degree framing it requires a trigonometric

formula, or a protractor, to determine the rise. In the absence of the protractor one may be

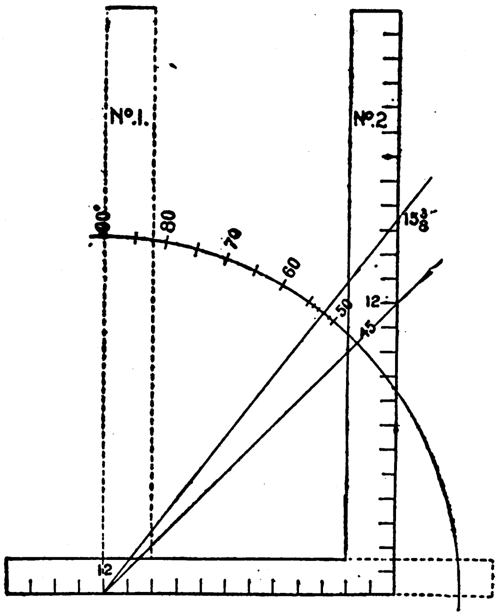


FIG. 133

temporarily devised as shown in Fig. 133, as follows:

Lay off an angle of 90 degrees, which may be done by marking from the heel of the square along both the blade and tongue The square, we will say, being in the position of No. 1, and with the angle as center lay off a quarter circle, the radius of which may be any size desired, the larger the more accurate will be the result.

Now reverse the square, as shown by square No. 2, and with the 12-inch mark on the tongue resting at the heel or angle of square No. 1. A line from 12 to 12 will bisect the quarter-circle at an angle of 45 degrees. Now with a pair of spacers divide the arcs thus formed into nine spaces, which will make the divisions five degrees apart, and by dividing these spaces into five equal parts will give the division of the degrees. However, it is only necessary to divide that section containing the desired degree. If it be 52 degrees then we divide the space about 50 degrees, as shown, and a line from 12 on the tongue and passing at 52 degrees will intersect the blade at 15⅜ inches and represent the rise per foot in the run.

In Fig. 134 is shown a diagram of how to find the lengths of the rafters to a given scale, also the bevels that give the cuts. The square may be applied to the angles instead of the bevels, if desired.

Without going further into the details of the construction of this diagram we will give the different parts as follows:

Let AB represent the run or seat of the common rafter, and with A as center lay off the arc and proceed as in Fig. 133 for the pitch.

BC will represent the rise, AC the length of the common rafter, BF the seat or run of the

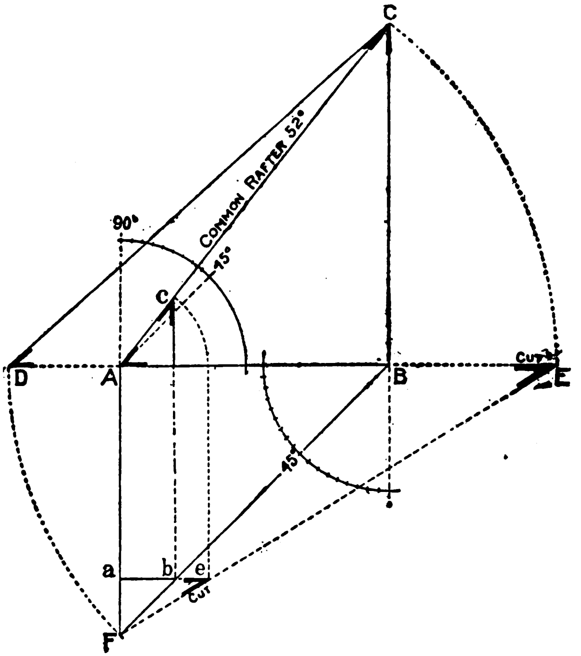


Fig. 134

hip (this line always rests at an angle of 45 degrees with AB, unless the adjoining sides of the roof are of a different pitch), and equals DB. DC represents the length of the hip and equals FE, the latter being drawn to obtain the bevels for the cuts. AE is obtained by dropping AC on a line with AB.

a, b represents the run of the first jack from

the corner, and by squaring up to AC, as shown, its length will be Ac, and represents the common difference in the lengths of the jacks. The seat and down bevels remain the same as for the common rafter, but require an additional bevel across the back to obtain the cut to fit against the hip. This is found by extending ab, intersecting FE, as shown, at e.

It will be seen that ae equals AC, and may, therefore, be taken for the length of the jack.

For the backing of the hip lay off one-half of its (the hip's) thickness from D on line DB (seat cut) will give the gauge line or the amount to remove to a center line at top of the hip.

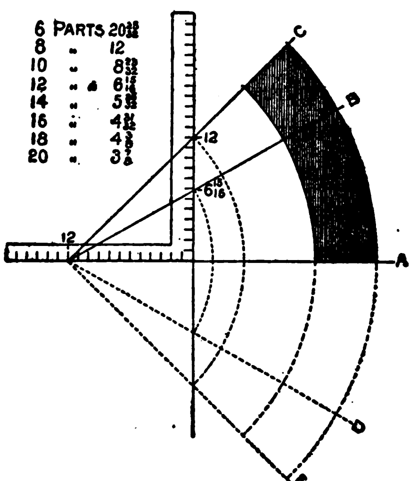


FIG. 135

The sectional part of a circular frame or wheel can easily be found by the aid of the square as follows: Draw line A, Fig. 135, and on it place the tongue of the square as shown, letting the 12-inch mark be the starting point.

Now suppose we wish to make a frame with eight equal parts. Draw a line from 12 on tongue passing at 12 on the blade, and on this lay off the desired radius, and swing down to A. The space from A to C will be the desired part. If twelve parts are wanted then draw the line passing at $6\frac{15}{16}$ on the blade. The part from A to B being that proportion.

If one-half the parts mentioned above are wanted then these parts may be doubled, or found as shown by the dotted lines below A. Great care must be exercised in laying out the diagram, the last variation of which will be multiplied by the number of parts used.

When making frames of very large diameters, it is better to increase the scale by raising the figures given by doubling, trebling, etc.

SOME POINTERS ON ROOF FRAMING

No matter what people may say to the contrary, there is no method or methods that has ever been devised that is so effective in roof framing, or results so rapidly achieved, as those which are obtained by the use of the steel square. I have shown in some of the earlier pages of this work how readily the length, and bevels of any common rafter may be obtained by the simple application of the square, any determined number of times. Thus for a building of, say, 30 ft. in width which is to have a roof of any given pitch, we arrange the pitch as I have shown, with so many inches on the blade for the run, and so many on the tongue for the rise This settled, we apply the square fifteen times to the rafter. 15 being half of the width of the building. This then gives the length of the rafter, and a line drawn along the edge of the tongue of the square will give the proper bevel for the top or plumb cut. If there is to be a ridge board on the roof, then half the thickness of such board must be measured back on the line drawn, and the rafter must be cut at that

point, this provides for the ridge board being nailed on the face of the cut without in the least changing the pitch.

A line along the edge of the blade, gives the proper bevel for the level or horizontal cut. If the bottom end of the rafter is to have a crow-foot cut on it to fit the plate, the workman will have no difficulty whatever in cutting the foot of the rafter to suit, as all the lines will be at right angles to each other, and a section of the plate may be made on the line of the bevel and the "cuts" laid off to suit the conditions.

In reviewing an article of mine on this method of laying out a rafter, an English carpenter took exception to it on the grounds that it would take too much time to lay out the rafters for a whole building by this "tiresome process," as he called it. Now, the Englishman was right from his point of view, but no American workman would ever think of laying out the rafters for a whole building by the process. He would simply make one rafter as I have shown for a pattern, and use this pattern for laying out all the other rafters for that particular pitch and rise on the same roof. Most workmen, however, make a pattern from thin stuff of some sort, as it is lighter and easier handled. The reviewer sug-

gested as a better way "that the pitch be arranged on the iron square, then measure across the angle from the points of run and pitch, and multiply this measurement by half the width of the roof to be covered." Now, this is all right, but, as a matter of fact, entails more labor of a "tiresome sort", and would use much more time than the method I have taught now for nearly forty years. The American workman, however, does not even require a suggestion as to the quicker method. He will see and adopt it at once without argument.

The method the Englishman would adopt is shown at Fig. 136, where the points of pitch and run are shown at 12 and 8, which makes the diagonal line 14½ inches. To get the length of the rafter for our supposed building then, we must multiply this 14½ inches fifteen times, then we must use the square at the top and bottom of the timber to obtain the necessary bevels for the cutting lines.

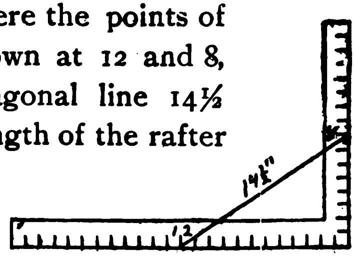


Fig. 136

Regarding this question of preparing rafters for a common roof, an "old hand" in the use of the steel square writes to me to say: "I do not

think that any simpler method can be given for finding the bevels at the heel and point of rafters than that which you have explained in your books, but, I do think that the following method for obtaining the lengths of rafters, is somewhat better than yours, particularly when employed for estimating purposes. The most common width of buildings in my locality is 24 ft., and with your permission I purpose to take that width for the practical test of my method. As you have given several ways by which the same result can be obtained, I will ask you to compare them with mine.

Finding the length of the hypothenuse by the old rule, we obtain for a one-quarter-inch pitch 13:4.99, or, as near as it can be used on the square 13 feet 5 inches.

Allowing one inch to the foot and trying your method we find, as the result, 13 inches and 7-16 scant, or 13 feet 5 inches. This is a very simple method, and when the rule is kept perfectly straight, the results are very satisfactory.

By my way I simply multiply the width of the building by the decimal .56, $24 \times .56 = 13.44$, or as near as can be worked by the square, 13 feet, 5 inches.

Let us try the same rule for a greater width—

say 60 feet. By finding the hypothenuse we find as near as can be used by the square, 33 feet, 6½ inches. By my method it would be 60 × .56, or 33.60, equal to 33 feet, 7 inches full. By this method the rafters in wide buildings are a little long. Thus, if the building is 52 feet wide, by the hypothenuse it would be 29 feet, 1 inch; my way it would be 29 feet 1½ inches. I consider this an advantage, as it leaves the point of the rafter very slightly open.

For a one-third I follow the same plan, only using the decimal .6 Unlike the decimal used for a quarter pitch the lengths are a very small fraction short; as, for instance, a rafter for a building 60 feet wide, by finding the hypothenuse, would be 36 feet, $\frac{1}{16}$ of an inch. By my way, 60 × .6 = 36 feet. A slight difference, truly. If building is 48 feet wide, then by the first method we find 28 feet, 10 inches full; by my way, 28 feet 9⅜ inches. A little practice will enable the mechanic to allow just enough to make up for the slight difference, so that when rafters are put together the fit will be perfect.

The one-half pitch can be found in the same manner by using the decimal .71. Taking the 24-foot building, length of rafters by the hypothenuse, we find 16 feet, 11⅔ inches; my way they

would be 17 feet full. Again, building 60 feet wide, rafters by the first method would be 42 feet, 6⅛ inches; by my way $60 \times .71 = 42$ feet, 6 inches. By using this decimal, the length is so near practically correct, that it may be used in all cases.

For a full pitch use the decimal 1.12, and as in the preceding mentioned pitch, and it will be found so near correct that it can be practically used in all cases.

It will be noticed that I have not made any allowance for projection of rafters over the plate. In this case gauge from the crowning side of your rafter the thickness of your projection; allow enough for the latter, and find the lower bevel according to the way you described in your last; measure the length of your rafter from where this bevel crosses the gauge line.

A little practice will enable the mechanic to lay off a rafter in a very short time. I have used the above myself, and have no trouble whatever. While I have no fault to find in your methods, as I know them to be correct, yet it is just as well that workmen should know other methods, as there are many occasions when the "only method" he possesses, cannot be applied. Hence I submit the foregoing, at your request.

W. H."

All this is very true, and right as far as it goes, but it so happens that many workmen do not have the necessary learning to work out these problems in roofing on the lines laid down by W. H., but, in order to meet conditions of this kind I have prepared a series of tables which I will insert in the next volume, giving the length of rafters for any building having a width of from five to sixty feet and a rise of roof of from one to eighteen feet to ridge. This will cover the whole ground, and form a ready table for the estimator to take his quantities from.

I may be pardoned for again showing the common and simplest method of laying out an ordinary rafter, for notwithstanding all I have said and described and explained on this subject, there will always be some persons who will not be able to grasp the method, unless it is put to them in some other light. I am sure of this from the long experience I have had in the answering of questions of this kind through the columns of different building journals. This is no doubt owing to some constitutional peculiarities of both the person who makes the inquiry and the person who attempts to answer it. This is one of the main reasons why I have admitted into this work various methods and

descriptions of others than myself, so that readers will have the same methods described and explained to them in several different ways by several writers.

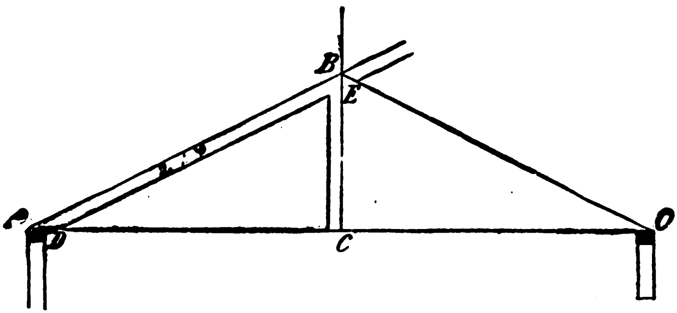


Fig. 137

Let us take the diagrams shown at Fig. 137, which shows a portion of a roof having a quarter pitch. CEB showing the height, and AB the length and inclination of rafter. D shows the foot of the rafter on the plate, cut "flat foot" and the line EC the plumb cut. This is quite plain. The building may be any width, let us say in this case, that it is 30 feet wide from A to O. That will make the distance from A to C 15 feet.

A method of obtaining the bevels for this rafter is given in Fig. 138 where the steel square is shown laid on the pattern with the points

inches on the blade and 8 inches on the tongue applied to the edge of the stuff. The line HO on the blade gives the bevel for the foot of the

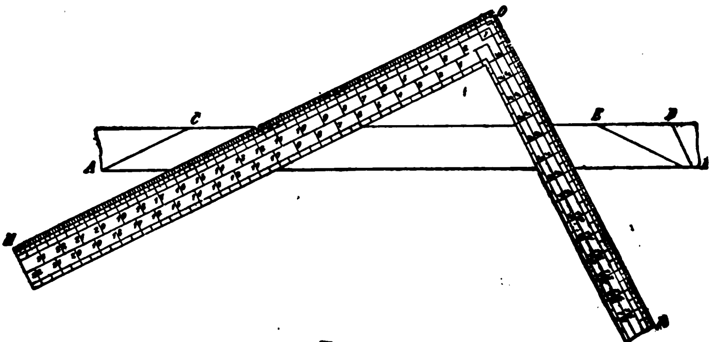


FIG. 138

rafter AC, as shown both in Figs. 137 and 138. The line OP, Fig. 138 gives the bevel for the top of the rafter or the plumb cut, as most workmen call it. Now, there is nothing in this diagram, which is from Bell's Carpentry, an excellent work,—from which the workman can get the length of his rafter, without complicating matters. Had the figures 12 inches and 6 inches on the square been employed instead of 16 and 8, then the distance across the diagonal from these two points would have equalled on the rafter, one foot on the base line, or seat of the rafter, so that 15 times that length would have been the total length of the rafter. Better still, however,

would have been the application of the square 15 times on the edge of the rafter pattern with the points 12 and 6 on gauge points, then both length and bevels would have been obtained at one operation.

The following, which has been kindly furnished me by A. W. Woods of Lincoln, Neb., will I am sure, help the student to an understanding of the subject of roof-framing generally. This relates more particularly to the framing of hip and valley roofs, a phase of the subject requiring study and attention of the learner.

Mr. Woods goes on to say: Much has been said and can be said on the subject, but it is my aim to say as little and and do as much as I can to make the subject clear. Every carpenter knows that the run and rise of the rafter taken on the square will give the seat and plumb cuts, but inasmuch as buildings are not all of the same width, it requires a different set of figures for each run, and as it requires an extra calculation to first find the run of the hip or valley, it is better to use the full scale for a one-foot run of the common rafter which answers for any run.

Referring to Fig. 139, we show a square bounded by A, B, C, D, the sides of which are 12 inches. E is at a point 5 inches from B, and

C 12 inches from B. B-A represents the run of the common rafter. E-A represents the run of

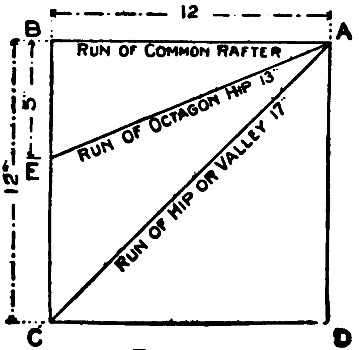


FIG. 139

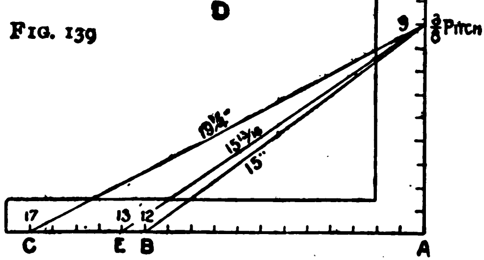


FIG. 140

the octagon hip or valley, and C-A the same for the common hip or valley, their lengths, being 12, 13, and 17 respectively. Now since 12, 13, and 17 are fixed numbers, we take them on the tongu of the square, as shown in Fig. 140. Now suppose we want to find the lengths and cuts of the rafters for the 3/8 pitch. We take 9 on the blade. Why? Because the run being 12 inches, the span must be two times 12, which equals 24, and since the pitch is reckoned by the span, we find that 3/8 of 24 is 9, which rep-

resents the rise to the foot run. Then 12 and 9 give the seat and plumb cuts for the common rafter, 13 and 9 for the octagon hip or valley, and 17 and 9 gives the same for the common hip or valley. In Fig. 141 I show each separately.

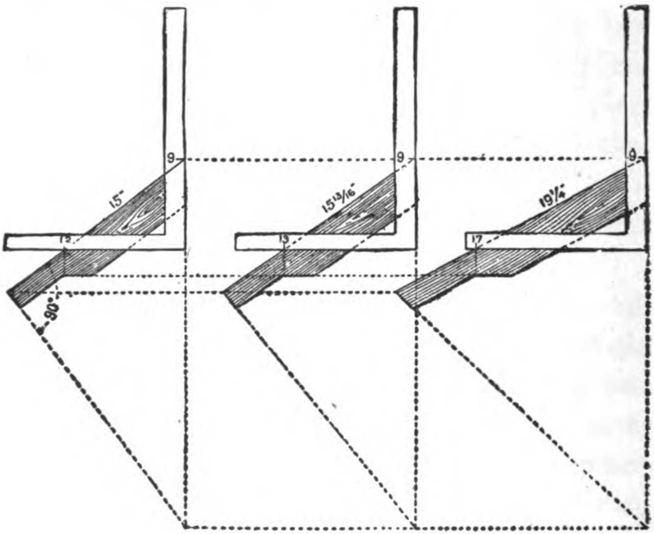


FIG. 141

The measurement line of hips and valleys is at a line along the center of its back, and just where to place the square on the side of the rafter so as to make the cuts and length come right at that point is a question that taxes the skill of most carpenters, especially so when the rafters are so backed. In Fig. 142, I have tried to make the above points clear.

First, I show the plan of the rafter. The cross lines on same represent an external corner

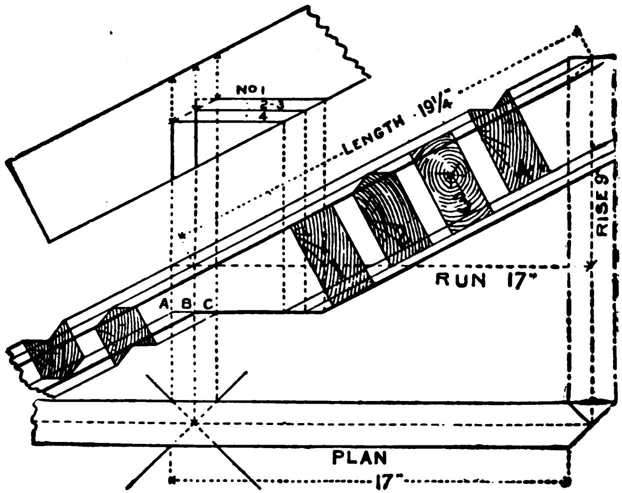


FIG. 142

for the hip and valley respectively. Above the plan is shown the elevation. The sections 1-2-3-4 represent the position of the rafters under the following conditions: No. 1 hip when not backed, No. 2 hip when backed, No. 3 valley when not backed, No. 4 valley when backed. No. 1 is outlined by heavy lines, and sets lower than the others. By tracing the bottom line of the sections down to the seat of No. 1, thence up to the second elevation will show just how deep the notching should be for each rafter. No. 1

cuts into the right hand vertical line from the plan, which would make it stand at the right height above the plate, but in order to make the seat cut clear the corner of plate, it is necessary to cut into the center line above the plan. No. 2 cuts into the same points as No. 1, but owing to its being backed, the seat cut drops accordingly. No. 3 cuts into the center vertical line, and in order to clear the edges of the plate must cut out at the sides to the left vertical line. No. 4 cuts in the same as the latter, but as much lower than No. 3 is No. 2 is below No. 1.

The outer vertical lines from the plan represent the width of the rafter. Therefore if the rafter be two inches thick, would be one inch apart, and this amount set off along the seat line (or a line parallel with it) will give the gauge point on the side of the rafter. To make this clearer refer to Fig. 141; 17 and 9 gives the cuts. Now leaving the square rest as it is, measure back from 17 one-half the thickness of the rafter, and this will be the gauge line point from which to remove the wood back to the center line of hip, and the measurement from the edge of the rafter taken vertically down to the gauge point set off on the plumb cut regulates how far apart the parallel lines of the seat

cuts will be under the above conditions. This rule applies to any roof so long as the pitches are regular.

Proceed in like manner for the octagon hip, the variation, however, is practically one-half of the above results for the square cornered building

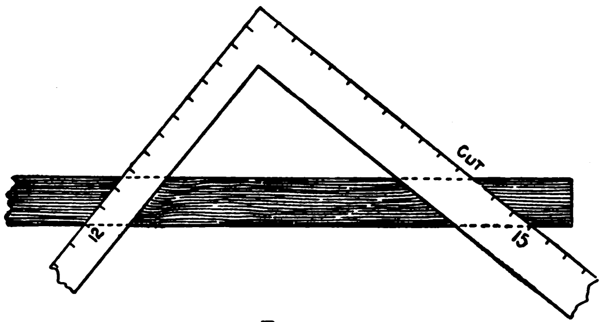


FIG. 143

Fig. 143 illustrates side cut of the jack, 12 on the tongue, and 15 (length of the common rafter) on the blade.

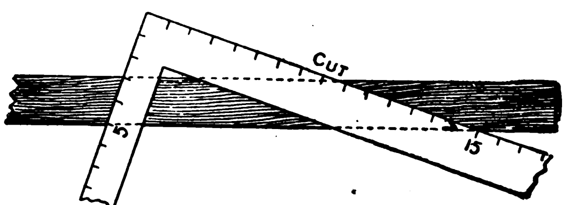


FIG. 144

Fig. 144 illustrates side cut of the octagon jack, 5 on the tongue and 15 on the blade.

Fig. 145 illustrates the side cut of the hip or valley, 17 on tongue, 19¼ (length of the hip) on the blade giving the cut in each case.

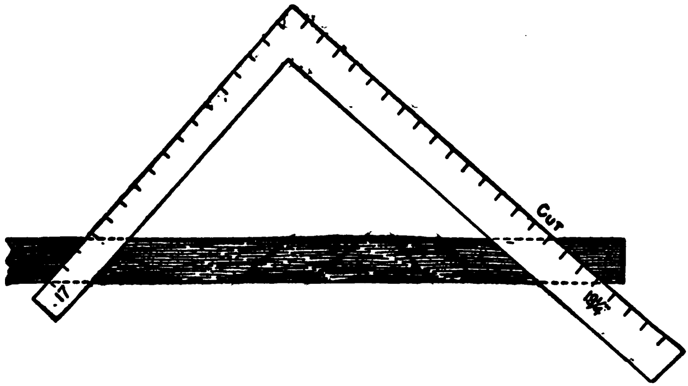


FIG. 145

The latter, however, is for the unbacked rafter. If it has been previously backed, then apply the square with the above figures on the lower edge at bottom of the plumb cut, or apply the square as for the jack, Fig. 144, to the backing line, which will give the same result as 17 and 19¼.

It is quite clear that when a workman cuts a common rafter he is also cutting a timber that would answer for a hip for a building of less span having the same rise, only taking some adjustment of the top bevel to fit gainst a ridge. This is quite plain, and if we refer to Fig. 146, we find that the common rafter for a 1-foot run

becomes a hip for an 8½-inch run, and that a hip for a 1-foot run of the building becomes a common rafter for a 17-inch run. Therefore, the rule that applies to the common rafter also

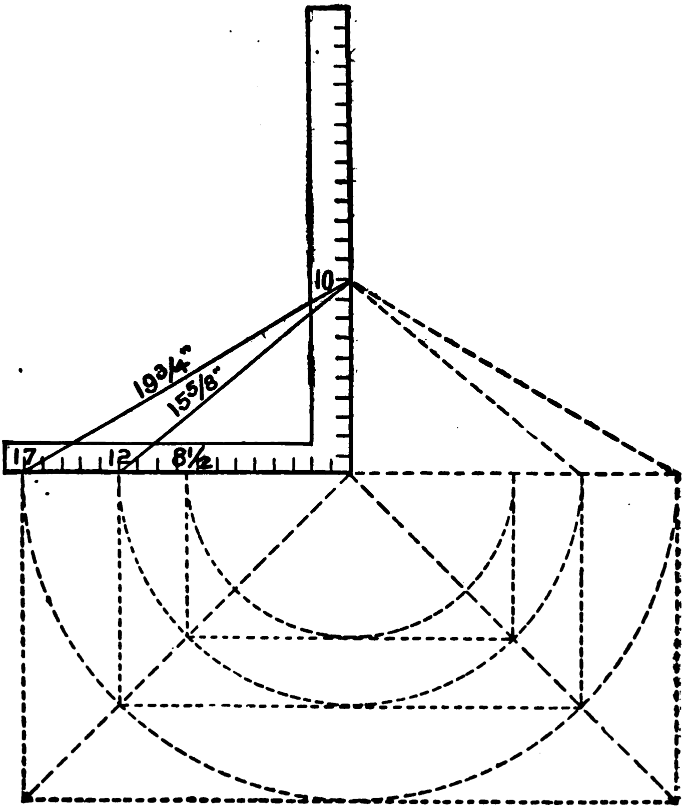


FIG. 146

applies to the hip rafter, *i.e.*, the run and rise taken on the square will give the seat and plumb

cuts. The run and length of the rafter taken on the square will give the side cuts, or taking the scale for a 1-foot run, Fig. 146, it is 12 on the tongue and the rise on the blade for the common rafter, and 17 on the tongue and rise on the blade for the hip. The tongue giving the seat cut and the blade the plumb cut. For the side cuts we take 12 on the tongue and 15⅝ inches on the blade, and the blade will give the side cut of the jack. Take 17 on the tongue and the length of the hip, 19¾ inches, on the blade and the blade will give the side cut of the hip. It would also be the side cut of the corresponding jack if it be a common rafter. Seventeen is used for a foot run of the hip rafter because the diagonal of a 12-inch square is practically 17 inches.

If we were to use 12 on the tongue for a foot run of the hip the rise to the foot would necessarily be less than 10 inches. In Fig. 147 I show what the difference is in rise to the foot.

From 12 to 12 is the length of the run of the hip, and this, taken on a continued line of the run of the common rafter, and an equal rise of the common rafter, set off as at A, and a line from this to 12 on the tongue passes at $7\frac{1}{17}$ inches on the blade, because the common rafter having

a rise of 10 inches to one foot, for one inch it would have $\frac{10}{12}$ of an inch, while the hip would only have $\frac{10}{17}$ of an inch to one inch and for 12 inches it would be 12 times $\frac{10}{17}$ equals $\frac{120}{17}$, or $7\frac{1}{17}$ inches. Therefore the figures given in the second illustration would give the same cuts as those in the first, but as the latter necessitates a calculation that ends in fractions—

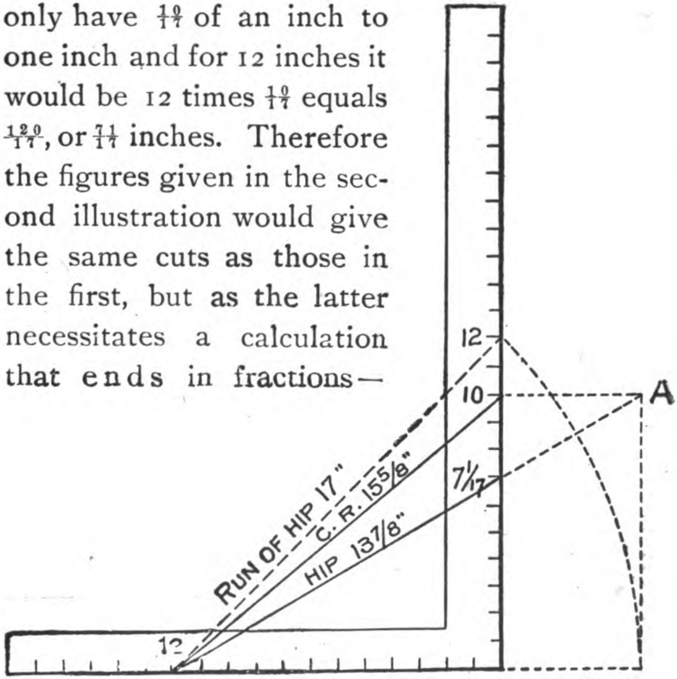


FIG. 147

fractions not given on the square—and for that reason 17 is generally used for a foot run for the hips and valleys.

AN UNEQUAL PITCH

In the matter of roofing over unequal pitches when there is no ridge and when all hips meet,

the building being longer than it is wide, the backing of hips and their lengths and bevels would be a very easy matter if a drawing of the whole thing was made, but, to obtain these by the use of the square alone, is somewhat more difficult. Let us assume the building to be 18 feet wide and 28 feet long, and having a rise of

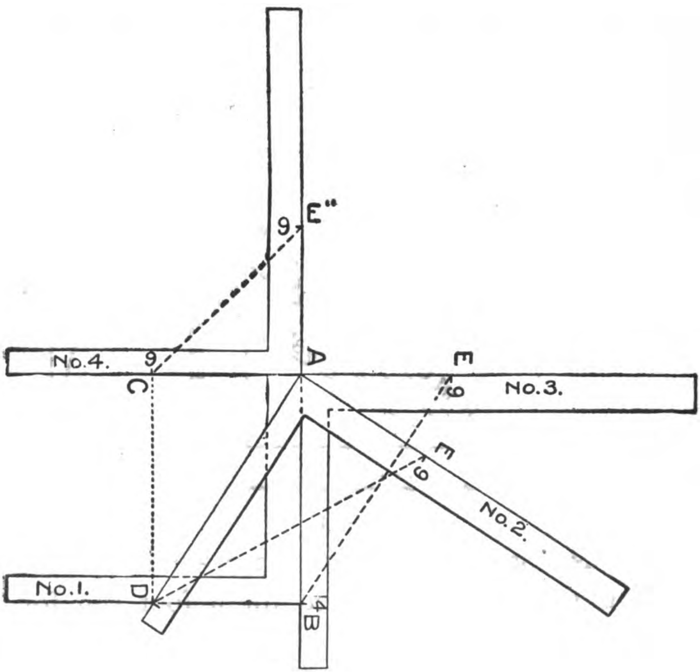


FIG. 148

9 feet, then, by referring to Fig. 148, we show to one inch scale the length, run, rise, seat, and

plumb cuts for the hip and common rafters as follows: The run of the long way of the building is 14, and 9 for the narrow way, which we take on the blade and tongue respectively, as shown on square No. 1, and to this apply square No. 2, as shown. AD equals the run of the hip. AE equals the rise and ED equals the length of the hip. The reader will notice that the letters A, B, C, D form a parallelogram, with side and ends equal to the runs of the common rafters. Therefore, by taking the runs on the tongue, as shown by the squares Nos. 3 and 4, will give their lengths, seat and plumb cuts.

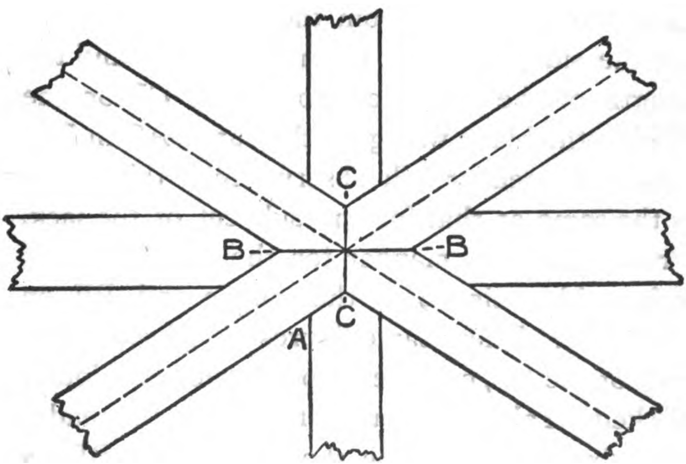


FIG. 149

In Fig. 149 is shown the intersection of the

rafters at the peak and as the lengths of all rafters are scaled to run to a common center it is necessary that the common rafters must cut back so as to fit in the angle formed by the hips. The proper deduction for this is shown in Fig. 150 by placing two squares on the back of the rafter, with the heel or corner of the squares resting on the center line. The distance from the corner of the square to B measured square back (at right angles) from the plumb bevel, as shown in Fig. 148, will locate the point of the long common rafter at B in Fig. 149. Proceed in like manner for the short common rafter, taking the distance from the corner to C, and for the side cuts, take 14 on the tongue and the length of the short common rafter CE on the blade—the blade will give the cut at AC in Fig. 149. The reader will observe that this angle is the same at that for the side cut of the jack. Proceed in like manner for the long common rafter side, using 9 on the tongue and BE on the blade. These same figures will give the side cuts of the hip, provided hip has been previously backed. Taking the last for example the reader will observe that 9 on the tongue and BE on the blade the square would lay on the plane of the backing and the blade giving the cut along

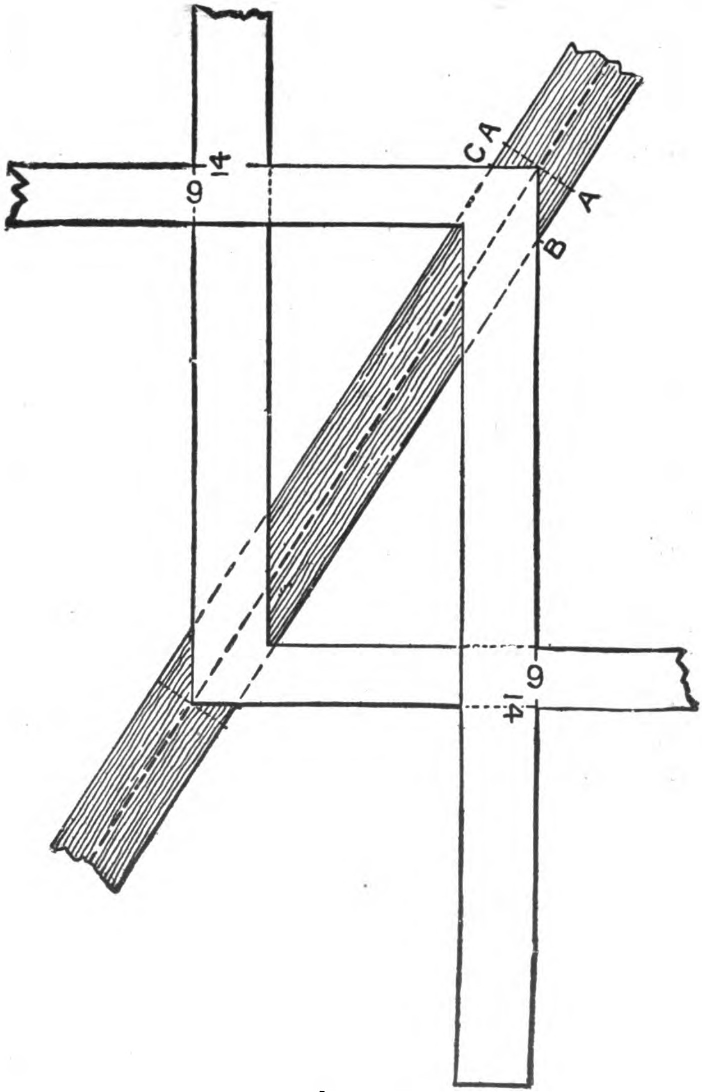


FIG. 150

the line BB in Fig. 149, or these cuts may be found by measuring square back from a plumb bevel at points A and A, Fig. 150, the distance AC and AB, which will give the proper plumb cut at the sides and intersecting the line AA at the center. These same distances, AC and AB, but transferred to opposite sides, set off on the seat cut or a line parallel with it, will give the gauge points on the side of the hip for the backing.

The lengths of the jacks may be found by dividing the length of the common rafter by the number of the spacings for the jacks, the quotient will be the common difference.

METHODS OF LAYING OUT A COMMON RAFTER

In several instances in this work I have endeavored to convey to the reader an idea of what is meant by the word *pitch* when referring to roof work. In many cases which I have met the phrase does not seem to be properly understood. Perhaps the following sketch, Fig. 151, and the description may aid somewhat in simplifying the matter. Let us suppose we wish to raise a roof and make it exactly a third-pitch; draw AB and AC at right angles as shown in Fig. 151. Describe an arc, as shown, from A as

center. Divide the arc in three equal parts as indicated by E and E′. Draw EA. Then, by

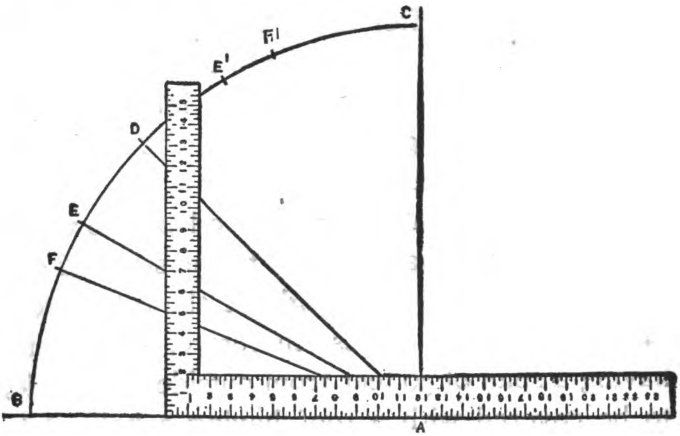


FIG. 151

placing the square as shown, we find that third-pitch, or a hexagon mitre, is 7 inches to the foot, instead of 8 inches, as some suppose. Divide the arc in four equal parts, as shown by FDF′ and drawing FA and DA we find that quarter-pitch, or the octagon mitre, is 5 inches to the foot, and that half-pitch, or square mitre, is 12 inches to the foot. From this, by the rule of square root, it will be found that the length of rafter on an 18-foot building for third-pitch is 10 feet 5 inches.

This may be put down as theoretically correct, but it is not the method usually employed by

workmen, nor is it the method recommended to be used, as for all practical purposes, in lying out the length of a rafter and getting the bevels for pitch of one-third, it is better to take 8 inches on the tongue of the square and 12 inches on the blade, which will give the rise of the roof near enough for all practical purposes.

The term "pitch" as understood by the workman, does not relate exactly to the slope of the roof, but rather to the height of the ridge from the level of the plates, therefore, a building having a span of 30 feet from outside to outside, to be covered with a roof having a half-pitch, will have its peak 15 feet above the level of the wall plates. Among the learned quidnuncs, the pitch of a roof is not known by "ratios" or quarters, thirds or half-pitches. If we examine the leading dictionaries we learn that the pitch of a roof is expressed in angular measurements in parts of the span. It is also designated by the proportion which the rafters bear to the span, and what is known in some places as common pitch, the rafter is ¾ the length of the span. The so-called Gothic pitch is formed by having the rafter the length of the span, which, when in place, forms an equilateral triangle, as shown in Fig. 152. The Elizabethan or knife-edge pitch

is formed by having the rafters longer than the span, as shown in Fig. 153. There are other definitions formed in dictionaries; for instance, we are told that the Grecian pitch produces a

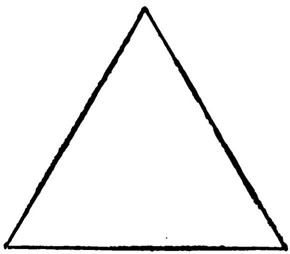


FIG. 152

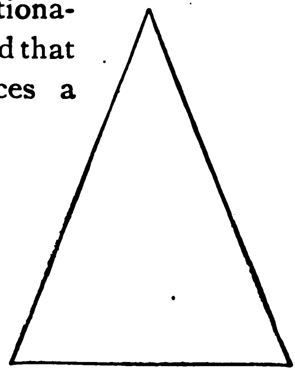


FIG. 153

roof the angle of which is from twelve to sixteen degrees with the horizontal, as at Fig. 154, and that the Roman pitch results in a roof the angle of which is from twenty-three to twenty-eight

FIG. 154

FIG. 155

degrees, as seen in Fig. 155. Another way of expressing "pitch" is based upon the length of the rafter in parts of the span. Thus, if the span is 30 feet, and the length of the rafter is 20 feet, the pitch would be said to be one-third pitch. From all this it is evident that, as yet, there is no generally accepted rule for defining

the "pitch" as relating to the length of the "rafter", either by "ratios" or otherwise. It is quite evident that the pitch of a roof, as now understood, relates rather to the rise than to any relation it has to the slope, therefore it is best to follow custom *most* generally accepted by the actual workman, and call a two-thirds pitch the one formed by raising the roof two-thirds above the level of the plates. This seems the most reasonable way, and will, sooner or later be universally adopted because of its eternal fitness and the readiness of being understood, as may be gathered from the following: Suppose we have a building having a 24-foot span to roof, a one-quarter pitch would be 6 feet rise, or 6 inches to a foot of run of rafter. The same run applies to all pitches; thus, 6 inches to 1 foot is one-quarter pitch; 8 inches to 1 foot is one-third pitch; 12 inches to 1 foot is one-half pitch, and 16 inches to 1 foot is two-thirds pitch, and so on. This is easily understood by the workman, and is as easily executed, if the operator understands how to use the steel square, and nearly every workman does nowadays. The method of defining the pitch of a roof by using degrees is troublesome, and not in keeping with modern progress, and will not work handily, as the

relation between the horizontal and the perpendicular is not easily defined, for the following reasons: Pitches of roofs are determined by a fractional part of the span, and by inches of rise to the foot of run of the rafter, and the reason that a one-half pitch is an angle of 45° is because the rafter happens to form a right angle, but it does not prove that we must divide the 45° angle to find the other pitches, but, even if it did, that would be no reason for using the terms "a pitch of 45°, or a pitch of 26° 30″ for a half-pitch or a quarter-pitch," as would be the case, as shown by the diagram, Fig. 156, if we adopted the degree method instead of the reasonable one now in use.

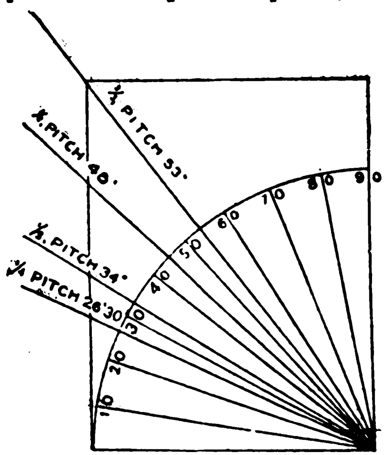


Fig. 156

There is no reason, however, why the workman should not make himself acquainted with all the known methods of determining "pitch", and the methods of laying out the work in accordance with such methods. It is impossi-

ble for a workman to know too much regarding his calling.

On this question of pitch, I think it proper to give my readers as nearly as possible all sides, and to this end I have obtained permission from Mr. Woods to publish the following, which is from his pen: "The word pitch has reference to the rise given the common rafter in proportion to the span. Therefore by letting 12 on the tongue represent the run of the common rafter the figures on the blade will then represent the rise in proportion to its length (the blade), as 6 being one-fourth of 24 represents the quarter-

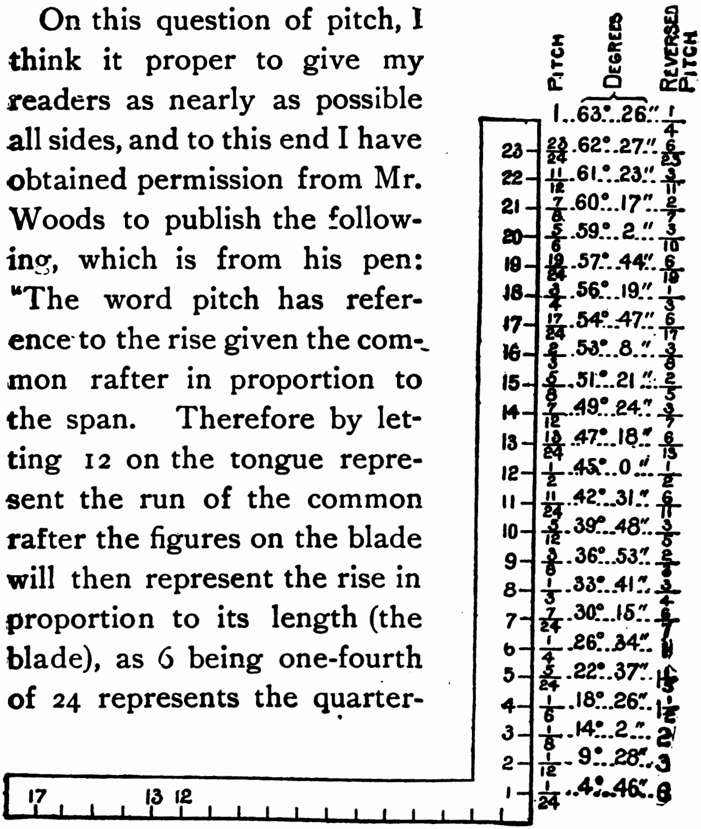


FIG. 157

pitch, 8 represents the ⅓ pitch, 12 the ½ pitch, etc. See illustration. Fig. 157."

For the corresponding hip or valley for the

octagon or square-cornered building substitute 13 and 17 on the tongue, respectively. However, neither are absolutely correct, but near enough for practical purposes.

The lengths taken diagonally from 12, 13 and 17 on tongue to the figures designating the rise on the blade represents the lengths of the above rafters for a one-foot run. Only three of the lengths out of the seventy-two are without fractions and they are for the common rafters, as follows: 12 to 5 = 13 inches, 12 to 9 = 15 inches and 12 to 16 = 20 inches. It is on the latter that the rule 6, 8 and 10, so generally used for squaring frame work, is founded. Of course, any of the other angles could be used for this purpose, but the above being without fractions are easy numbers to remember.

The length of the common rafter doubles its run or has a length equal its span when it has a rise of 60°, which taken on the square is 20.784 inches rise to the foot. The same occurs of the octagon hip when it has a rise of a fraction less than 23 inches, and that for the common hip at nearly 29½ inches rise to the foot.

In the illustration I also give the reversed pitches. That is, by letting the blade represent the run and the tongue the rise. The length of

the diagonal lines in that case becomes the length of the rafter for a one-foot rise to the inches in run taken on the blade.

The reader will notice that several of these pitches are transposed and are found in the first column, as follows: The 1 pitch is the same as the ¼ pitch when reversed. The ¾ same as ⅓. The ⅔ same as ⅜. The ½ remains unchanged. The low pitches in the first column become very steep when reversed. Thus, the $\frac{1}{24}$ pitch becomes 6 pitches or a rise of 12 feet to a 1-foot run. The $\frac{1}{12}$ pitch is equal to a rise of 6 feet to a 1-foot run, etc.

For the corresponding lengths of the hip or valley for the reversed pitches add $\frac{1}{12}$ and $\frac{5}{12}$ to the run of the common rafter for the octagon and right-angled corner respectively. In our illustration we also give the degree of pitch for the common rafter. To find the same for the reversed pitches, it is only necessary to subtract the degrees here given from 90°.

I may have to revert to the subject of "pitches" again, as there are still some points on the subject, from a workingman's point of view, that will bear further discussion.

Quite a graphic method of laying out a common rafter is shown at Fig. 158. This, it

will be seen, is the method described in the forepart of this volume, with some additional

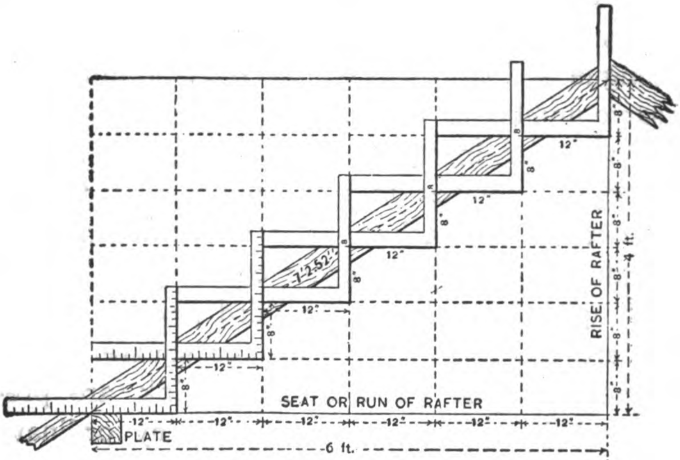


FIG. 158

explanation. Here the rafter is shown in position, with the square shown on each foot of the run of the rafter; also the rise for each foot. The illustration shows a rise of 4 feet or 48 inches in a run of 6 feet or 72 inches. The square is applied upon the line representing the center of the rafter, and shows the length from the center of the ridge to the top of the plate. By the conditions of the problem the rise of the rafter is 8 inches to every 12 inches of run; accordingly 12 of the blade is taken to 8 of the tongue on the length of the rafter, as shown in

the diagram. Any other number of inches to the foot can be obtained in the same manner. Hip and valley rafters can be got in the same way, simply taking the rise in inches on the tongue and 17 inches on the blade, running the same number of times as for the straight rafter. The reader in making use of this plan should always remember to run a gauge as far down the rafter as notched. The measurements are made from the top corner of the plate. The example shown illustrates third pitch, as 8 and 12 are the figures used on the square. This illustration and explanation, I think, are presented in such a manner that any ordinary intellect can grasp it all.

SOMETHING ON HIP ROOFS

In referring again to hip roofs, I know I am on lines the young workman likes to follow—and many old ones as well—for in these days there is such a strong tendency among architects to cut up roofs into as many gables, hips, valleys, saddles, as can possibly be crowded in. This is a remnant of the Queen Anne fad of thirty years ago; a fad that has left us so many country houses with gables, towers and peaked corners, the best of which can be said of them is, that

they are somewhat picturesque. As said before, the cutting of a hip or valley rafter is the same as cutting a common rafter for a building of different dimensions with the difference that when used as a hip or valley rafter, the top end must have side as well as plumb bevels. In order to make this plain, examine the plan shown at Fig. 159. Here DB and CB show the seats or lines of the hips; now if CB was moved so as to run in the direction of S, then DBS would show a gable with its face towards C, thus showing that a hip rafter is an extended rafter made to meet certain conditions. This plan shows besides the hips, common rafters, jacks and ridge, with projection over eaves. The line EAF, may represent a junction with another portion of the building. A side elevation of the roof is given at Fig. 160 showing hip, jacks, ridge, and common rafters in position.

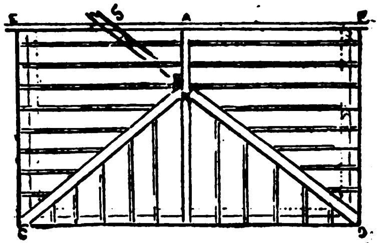


FIG. 159

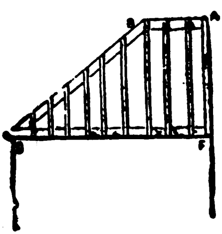


FIG. 160

In order to give a clear idea of how a hip roof

should be laid down on plan, I exhibit the following diagram, Fig. 161. Let BEXY represent the ends of a regular roof having a ridge, DZ, in the center. Make DC on the plan equal to half the width EB; then the angle BCD will be a right angle. Draw any line, as AC, at right angles to DB from D. Set off the height of the roof, as DF and draw FB, which will be the length of the hip rafter. Put one foot of the compasses in the center of the line AC, and with the other describe a semicircle, touching the line FB in the point R. In other words, the semicircle to be drawn is of such a radius as will make it tangent to the line FB in the point R. From the point T, at which the semicircle cuts

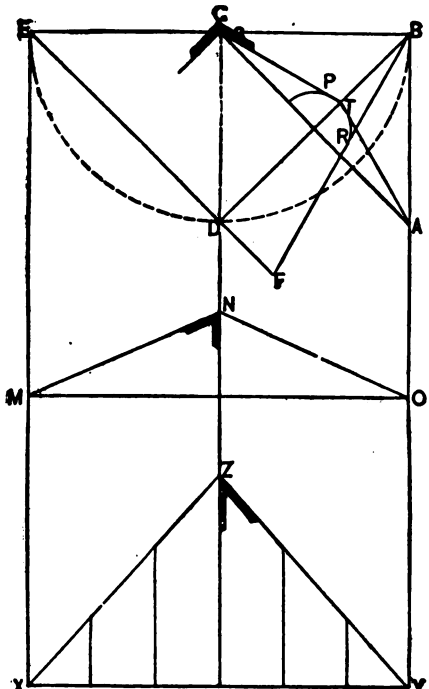


FIG. 161

the line DB, draw TA and TC, which will give the form of the backing of the hip rafter.

To find the length of the jack rafters and their bevels to fit the hip rafter, make the hip QX and ZY equal to the hip line BF, and square up the jack rafters, as seen in the plan, until they meet the hip, which operation will give the length of each jack rafter for the ends and also for the sides of the roof. It will be readily perceived that the bevel S is the side bevel of the jack rafters, and also the bevel to miter the upper ends of the truss. The bevel N, which is the down bevel of the common rafters, will also be the down bevel of the jack rafters at the hips. This is but one of the methods by which a hip roof may be laid out, without the aid of the square. There are many other methods, some of which I will illustrate and describe in Vol. II.

Another diagram shown at Fig. 162, exhibits a roof that has an acute and an obtuse corner as well as corners at right angles. The hips and the method for obtaining the backing for them are shown quite clearly and do not require further explanation.

An old, but very reliable method of finding the lines and bevels for backing a hip, is shown at Fig. 163, where ABCD is the plan of the roof;

draw the diagonals AC and BD, over which hip

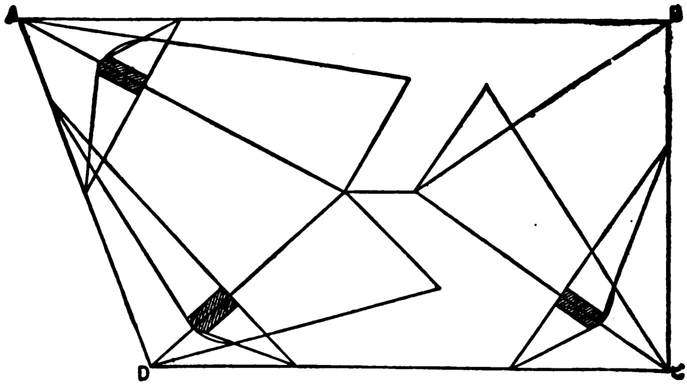


FIG. 162

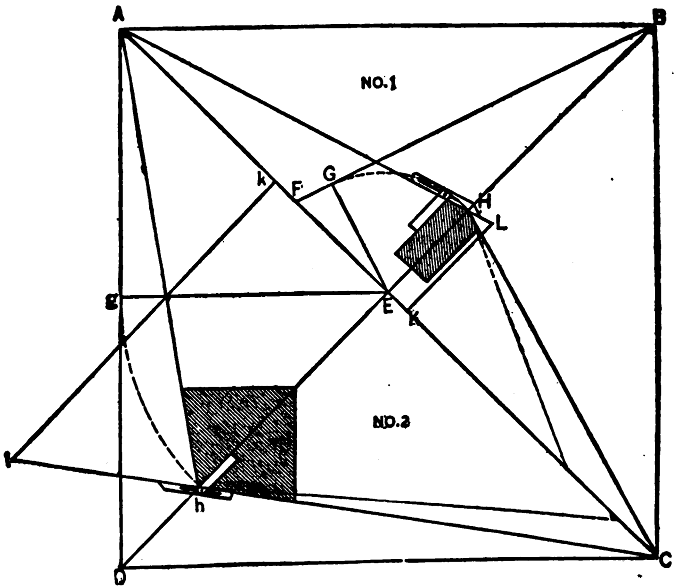


FIG. 163

rafters rest when in position. On the line AC for pitch No. 1, make EF equal to height of roof; connect FB, which is length of hip rafters; make EG perpendicular to FB. On line EB make EH equal to EG; connect AHC. The enclosed triangle will be a section of roof formed by a plane cutting from line AC at right angles with hip rafter. The shaded figure at H shows the position of hip rafter and manner of setting bevels. To prove the rule, make AK equal to length of hip rafter, and KL equal to height of pitch; connect AL. The angle at L being equal to angle at H, proves the rule to be correct on a flat pitch.

On the lower side of line AC, pitch No. 2, I have made the height equal to EA. AD is the length of hip. E*h* is equal to E*g*, and C*h*A is section of roof as before. C*k* is length of hip; *lk* is height of pitch, the angles at *l* and *h* being equal as before. The lines can be obtained with the square as follows; the tongue of square represent the side of the rafter—the blade for the base and the straight-edge the top of the rafter. Another method of backing a hip rafter is shown at Fig. 164. First lay off cut, and AB the line of the plumb cut, from A draw AC perpendicular to AB. Lay off AE, making it

equal to one-half the thickness of the hip. Through E draw GF parallel to the top of the

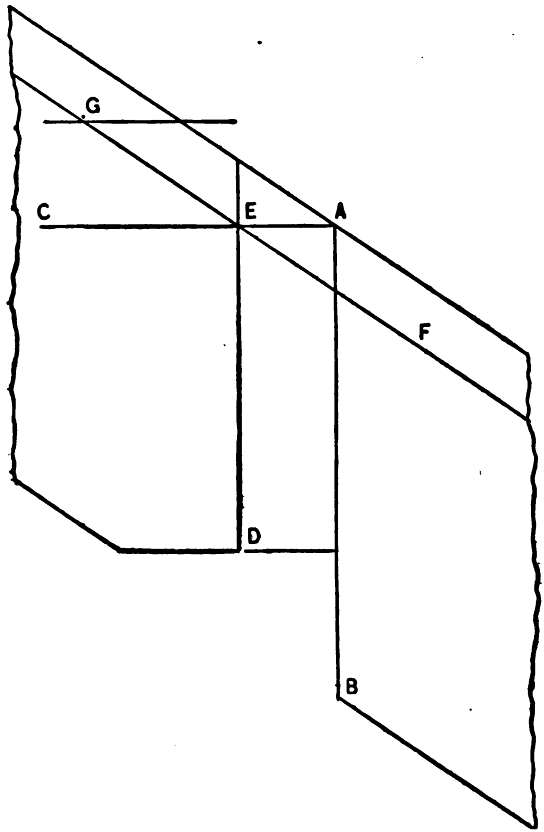


Fig. 164

rafter, and GF is the amount to be taken off in order to make the proper backing, working, of course, to the center of the hip. This is on the

supposition that the seat of the hip is at an angle of 45 degrees with the side of the building. For octagonal or other such roofs in place of laying off from A one-half the thickness of the hip, draw DE parallel to AB, letting D be the point where the plate of the building intersects the side of the hip.

A very good method of obtaining the lengths of jack rafters was sent to *Carpentry and Building* some time ago by a correspondent, and I think worthy of a place in this work, as it is quite a time saver.

In this case the common rafter strikes the ridge at the point of the hip. Suppose the common rafter, Fig. 165, is set off 8 inches from the point of the hip, the rafters being 24 inches on centers and half-pitch, we have 24 – 8 = 16.

Take 16 and 16 on the square, which will give the length of the longest jack on the short side. Thirty-four inches off gives the next jack, and so on. The sketch shows so clearly what is meant that further description would seem to be unnecessary.

The methods given herewith for obtaining the measurements and bevels for hips, valleys, jacks, and common rafters may be considered as reliable. We suppose the hips and valleys are

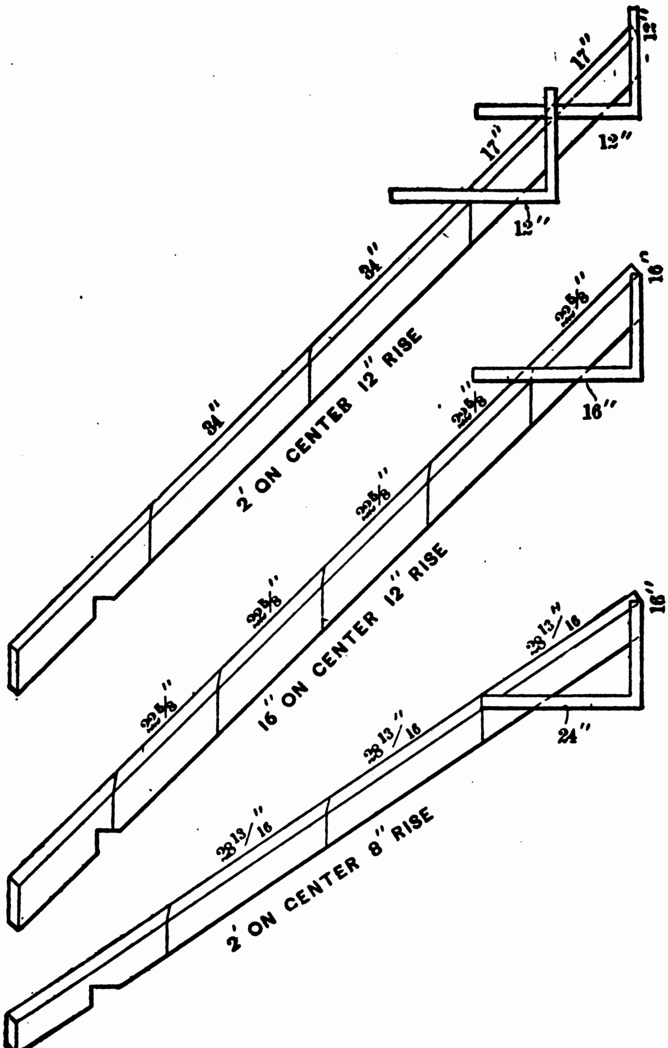

12"
17"
12"
17"
12"
34"
34"
2' ON CENTER 12" RISE
16"
22⅝"
16"
22⅝"
22⅝"
22⅝"
22⅝"
16" ON CENTER 12" RISE
16"
28 13/16"
24"
28 13/16"
28 13/16"
2' ON CENTER 8" RISE

FIG. 165

at an angle of 45° with the eaves. Suppose the roof to be one-third pitch, or, in other words, to have 8 inches rise to the foot; then take 8 inches on the tongue of the square and 12 inches on the blade, and apply to the rafter as shown in

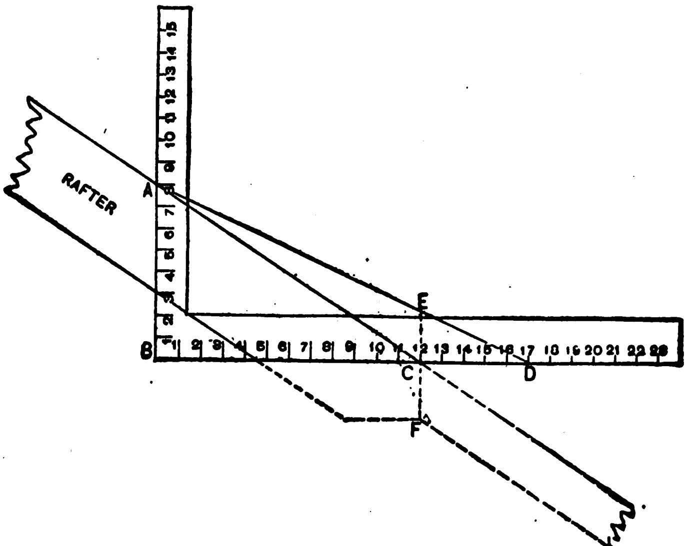


FIG. 166

Fig. 166. Take this measure as many times as there are feet in half the width of the building. This will be the length of the common rafter without the projection. This is to be added as indicated by the dotted lines. The bevel for the top of the rafter is indicated at A, and for the heel of the rafter at C.

To get the length of hip and valley rafters change the measure on the blade of the square from 12 to 17 inches, as shown by ABD in Fig. 166, and take this measure the same number of times as for common rafters. The down bevel for top of rafter is at A, and for heel is at D. Take the measure of the hip rafter to the point of miter at the top end when mitered to fit ridge board. Half of the thickness of the ridge board is to be taken off both hip, valley, and common rafter measurements. This will be better under-

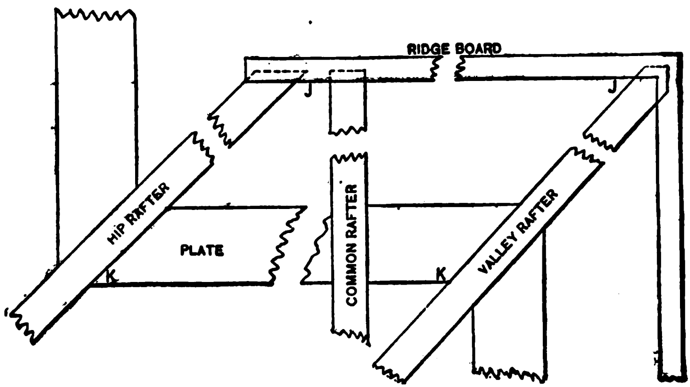


FIG. 167

stood by examining JK of Fig. 167, of the diagrams. The plumb-line CF, Fig. 166, stands plumb over the face of plate and must be the same length in hip and valley rafters as in common rafters. This makes the projecting

part of hip and valley rafters wider than of common rafters.

To get the length of the jack rafters apply the square the same as for common rafters, as indicated at ABC, Fig. 166, once for every foot. They are placed on the plate from the foot of hip rafter or corner of building. Time may be be saved by marking the foot measurements on the pattern of common rafters and transferring them, as may be required, to the various lengths of jack rafters. The half-thickness of ridge board of hip or valley rafters, as the case may be, is to be taken from these measurements as required. The down and foot bevels are the same as in the common rafters. The top bevel is obtained by taking 12 inches of the base BC on the tongue, and 14½ inches (nearly) of hypothenuse on the blade AC, Fig. 168, and applying it as shown by GHI of Fig. 166. The top bevel of the jack rafter is at I, while G gives the face bevel for sheeting. Eight, and 14½ inches taken on the square in the same manner, marking out 8 inches, gives the edge bevel of the sheeting. The top bevel of hip and valley rafters is obtained in the same manner as for jack rafters, only it is treated as a jack rafter in a flatter-pitch roof. From this it may be laid

down as a rule that the base and hypothenuse of a right-angle triangle forming the pitch of any

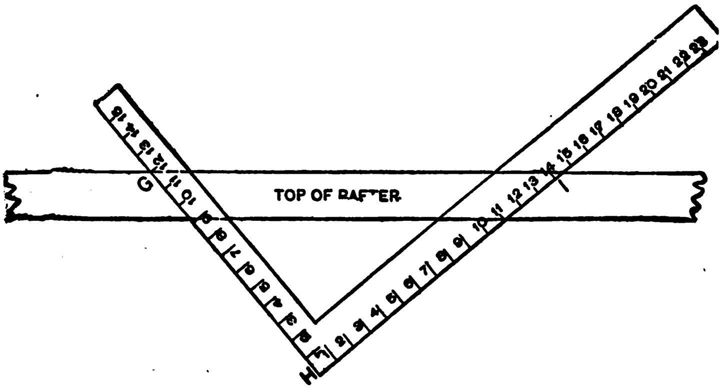


Fig. 168

roof or rafter taken in any proportion on the tongue and blade of a square, and applied as shown by GHI of Fig. 168, will give the top bevel of hip, valley and jack rafter, as also the bevel of the hip and valley shingles and for mitering a raking frieze. In laying out for cutting miters on purlins for a hip roof, the following method is a very good one: Let ABCD, Fig. 169, be the purlin, E, the common rafter drawn to correct pitch, FGH, the plan of the angle of the building, and GI, the plan of the hip. From the angles, AD, and C, of the purlin, draw lines AJDKCL, parallel to FG; make KN, equal to the depth of purlin and

KM, equal to the thickness of same; draw NO, and MP, parallel to FG. From the points where the lines from A and C cut the plan of the hip, draw JP and LQ square from FG; join QK and KP. The angle of RKQ, will be the level for the down or side cut, and the angle MPK, will be the bevel for the cut across the edge. In setting out, it is advisable to mark the purlin as near full size as possible, to insure the bevels being accurate.

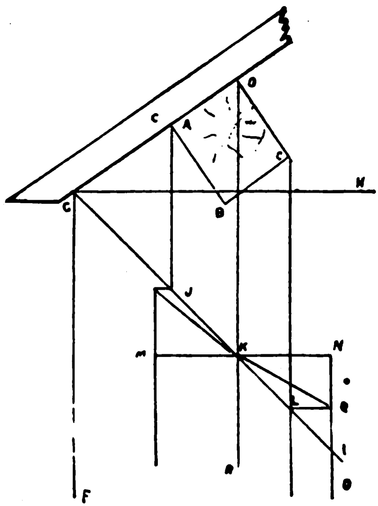


Fig. 169

A quick way of finding purlin lines by the square is given herewith: for the top and down bevels of purlins in a roof which rise 16 inches in 12 inches run use the following figures: For the side bevels take 16 inches on the tongue and 20 inches on the blade of the square and the tongue will give the bevel required. For the top bevel take 12 inches on the tongue and 20 inches on the blade of the square and the tongue

will give the required bevel. The bevels for 8-inch rise and 12-inch run are as follows: For the top side take 12 inches on the tongue and 14⅜ inches on the blade of the square and the tongue will give the required bevel. For the side bevel take 8 inches on the tongue and 14⅜ inches on the blade of the square and the tongue will give the required bevel.

OCTAGON FRAME WORK

The following modern methods of working out octagon frame work, have been gathered from many sources, chiefly from the actual workings of the men who themselves have either designed the methods or executed the work; and where I have been unable to examine the work, I have in my own workshop tested the methods, either by making models or laying out the lines and proving their correctness.

The secrets of the octagon, or in fact of all workable polygons, are perhaps better exposed to the light of day in "Wood's Key to the Steel Square," than it is possible to show in these pages under the conditions to which ordinary book-making is limited. However, I deem it just to my readers to give a short chapter in this volume on the subject of octagon roofs, leaving

for the following volume, a more extended discussion of the subject. Let the plan and

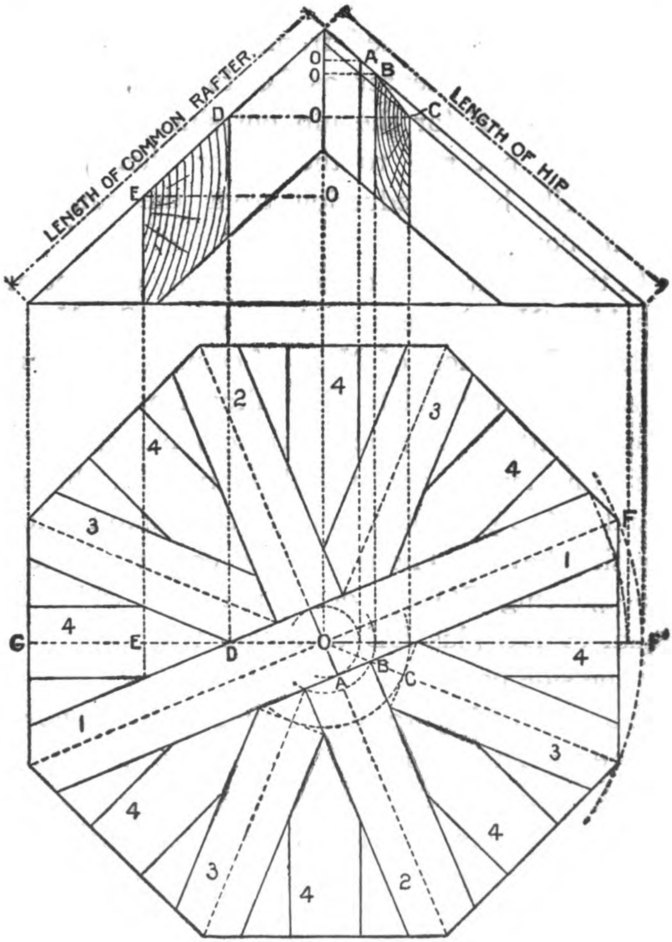


FIG. 170

elevation of an octagon roof showing the runs of the common and hip rafters as exhibited in Fig. 170, be the ground work of this problem. The runs are reckoned from the outer edge of the plates to the center, as GO for the common rafter and OF for the hip, but since all of the rafters do not run to the center there must necessarily be a deduction from the runs, as given above.

In the plan it will be seen that only one set of the hips (No. 1), meet at the center. Set No. 2 lacks the thickness of No. 1 of coming together, or an amount equal to OA taken from the run of each rafter. The next two sets, No. 3, are of the same length, and the deduction for this is equal to OB plus BC to obtain the plumb cut for the side bevel. The run of the common rafter, No. 4, being GO the deduction from which is equal to DO plus ED to obtain the plumb cut for the side bevel.

Now, referring to the elevation, the above reference letters are used for like measurements, showing the proper deductions to be made to obtain the lengths for the different rafters by simply squaring back from the plumb cut.

The run and rise taken on the square

regulates the seat and plumb cuts, but the above deductions remain the same for any pitched roof.

In laying out a plan of an octagon figure, it is first necessary to understand how this may be done quickly and correctly. One of the simplest methods of forming the figure is shown at Fig. 171, where the corners of the square are used as centers, and the center A of the square for radius. Parts of a circle are then drawn and continued until the boundary lines are cut. At the points found draw diagonal lines across the corner as shown, and the figure will be a complete octagon, having all its sides of equal length.

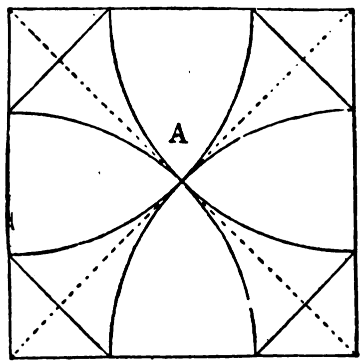


FIG. 171

To get the cut of miter of the angles we fall back on the steel square and take the figures 12 and 5 which gives us the correct cut very nearly, as shown at Fig. 172. It is unnecessary here to explain why these figures give the desired angle, as that will be talked over again. However, it may not be amiss to hastily glance at them en

passant. A line from 12 on the tongue and

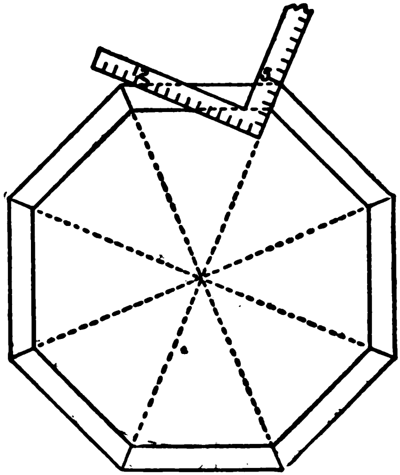


Fig. 172

crossing at 5 on the blade forms an angle which

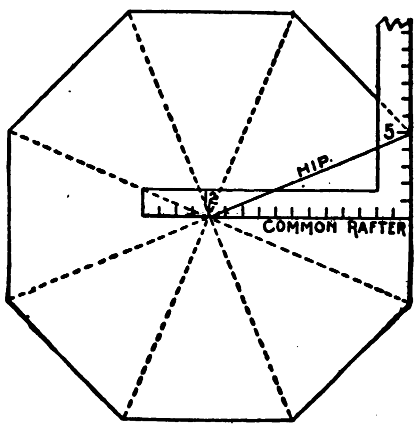


Fig. 173

is the same as that formed by the runs of the common and hip rafters of an octagon roof and base of which is represented in Fig. 173.

We also find that this line diverges from the tongue 5 inches in a 1-foot run. Hence the side of an octagon 1 foot in diameter must be 5 inches (see Fig. 174) or $\frac{5}{12}$ its diameter. This proportion always exists whether it be inches,

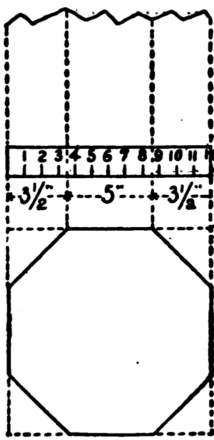


FIG. 174

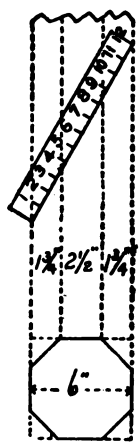


FIG. 175

feet or yards. Thus the side of an octagon 1 inch in diameter would be $\frac{5}{12}$ of an inch. A 6-in. diameter would be 6 × 5.12 = 30.12 or 2½ inches, Fig. 175.

Again, from 12 to 5 measures exactly 12 inches, a gain of 1 inch to 1 foot run of the common rafter. Therefore the run of an

octagon hip is $\frac{1}{12}$ longer than that of the common rafter.

Now, let us apply the above to the full size diagram, as shown at Fig. 176.

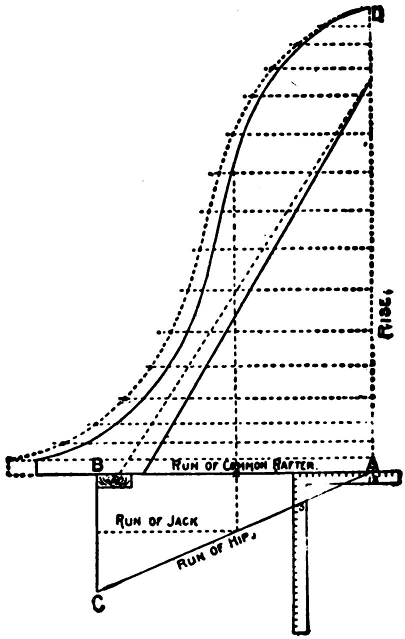


FIG. 176

Draw BA. Place the square as shown, and draw line AC, and square down from B to C. AB is the run of the common rafter. AC is the run of the hip, and is $\frac{1}{12}$ longer than AB; BC is equal to one-half the length of the plate, and is $\frac{5}{12}$ the length of AB. The whole figure bounded

by AB and C, is 1.16 of the plan, and is all that is necessary to draw.

Now, lay off the rise AB, and the desired curve for the common rafter, and draw any number of lines parallel with AB, from the rise to a few inches beyond the curve of the common rafter. Now, measure these lines from rise to curve, and for each foot and fraction of foot add to same line as many inches and twelfths of inches as there are feet and inches in length.

In other words, if a line is 6 feet and 9 inches long, add to its length 6.9, 12 inches and make a dot. After all lines have been thus measured, run an off-hand curve through the dots, and the corresponding hip is determined.

The jack being a part of the common rafter, its shape is easily found by laying off the run and squaring up as shown.

It is thought better to run only the hips to center and by using an octagon shaped block or pole set with the sides, so that the hip will rest against it squarely so as to get good nailing, as shown in Fig. 177, besides, letting the block

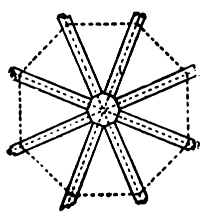


FIG. 177

extend above roof furnishes an excellent stay for a finial.

The cuts are all contained in figure bounded by ABC and D, but are not shown in this diagram. This subject will be discussed again, when describing the framing of octagon towers and spires.

PRACTICAL TREATISE ON THE STEEL SQUARE.

VOL. I.

QUESTIONS.

1. Describe what is "the face," "the back," "the body," and "the tongue" respectively of the steel square.
2. In "Rule for framing," what does the first line of figures give?
3. What does the second line of figures give?
4. What does the third line of figures give?

5. What does the fourth line of figures give?
6. What does the fifth line of figures give?
7. What does the sixth line of figures give?
8. What does the seventh line of figures give?
9. If a roof is raised 8 inches to the foot, what pitch is it called?
10. If a building is 16 feet wide, what will be the run of common rafter, and the figures used to find the length.
11. What figures will be used to obtain the bottom and top cuts of common rafter.
12. Upon what line of the "square" and what figures will be used to find the correct length of hip or valley rafter?
13. What figures on second line of "square" will give top and bottom cuts for hip or valley rafters?
14. Upon what line and what figures will be used to get length of first jack rafter and the difference of the others spaced 16 inches on centers, and give example?
15. Upon what line and what figures will be used to get length of first jack rafter, and the difference of the others spaced 2 feet on centers, and give example?
16. Upon what line and what figures will be used to get side cut of jacks against hip or valley rafter?
17. Upon what line and what figures will be used to give side cut of hip or valley rafter after ridgeboard or deck?

18. Upon what line and what figures give the cut of sheathing and shingles in valley or hip?

19. What other "cuts" can be obtained from the figures on the "square" that give side cuts of jacks?

20. What other "cuts" can be obtained from the figures on the "square" that give cuts of sheathing in valley or hip?

21. Describe how to obtain the bottom and top cuts of hip or valley rafter.

22. Describe how to obtain the bottom and top cuts of common rafters and jack rafters.

23. Describe what is meant by the "octagon or eight square scale" and give illustrative sketch.

24. Explain what is meant by the "Brace Measure" and give example.

25. Give a few suggestions as to how to take care of the "square."

26. Describe the "diagonal scale" on the steel square, and give a sketch of same.

27. Describe what is meant by "the run of a rafter."

28. Describe what is meant by "the rise of a roof."

29. Describe what is meant by "the pitch of a roof."

30. How may the cuts or angles of a rafter be obtained by application of the "square" and give sketch illustrating.

31. Describe "the rafter table" on the steel square.

32. Describe how to find the length of rafter for a roof with 1/6th pitch and having a run of 12 feet.

33. Describe how to find the length of a rafter for a roof ½ pitch and a run of 12 feet.

34. If the run is 25 feet how would the length of rafter be obtained?

35. When the "run" is in inches, how is the rafter table to be read?

36. If the "run" is 12 feet 4 inches on a ½ pitch roof, show how rafter length may be obtained.

37. Explain what is meant by the "Essex Board Measure Rule" and give illustrative sketch.

38. Give description of the "Bridge Builders' Square."

39. Give description of the "Machinists' Square."

40. Give description of the "Bench Square."

41. Give description of the "Crenelated Square."

42. Give description of "Combination tool" consisting of slotted square and rules, and the uses to which it can be applied.

43. Give description of the "Adjustable try steel Square."

44. Give description of "Combination Square, Miter and Inclinometer."

45. Give description of "Starrett's Carpenters' Square."

46. Explain the use of "Starrett's Stair Gauge Fixtures."

47. Give description of the "Key to the Steel Square."

48. Explain how to find the lengths and cuts for the ½ pitch.

49. Explain how to find the corresponding octagon hip and the common hip or valley.

50. Explain how to find the common difference in the length of jacks.

51. Explain how to find the common difference for the octagon jack.

52. Explain how to find the side cut of the jack.

53. Explain how to find the "side cut of the octagon jack."

54. Explain how to find the "side cut of the hip or valley."

55. Explain how to find the "Backing of the hip."

56. Explain what the figures in the two circles of the "Key" represent.

57. Explain how to frame a roof with 30° pitch.

58. Explain how to find "common rafter" for same.

59. Explain how to find "octagon hip."

60. Explain how to find "hip or valley."

61. Explain how to find "side cut of jack."

62. Explain how to find "side cut of octagon jack."

63. Explain how to find "side cut of hip or valley."

64. Explain how to frame a roof with 60° pitch.

65. Explain how to find the miter for any regular polygon.

66. Explain how to find the miter for a "non-agon" (9 sides).

67. Show how to frame timbers at any degree of pitch.

68. Give description of "Reissmann's Rafter and Polygon Gauge" and its uses.

69. Give description of "double-slotted fence" in connection with steel square.

70. Give description of "single-slotted fence" in connection with steel square.

71. Give description and sketch showing application of "square and fence" in laying out a stair string.

72. Give description and sketch showing application of "square and fence" in laying out rafters to a line.

73. Give description and sketch showing how to lay off a rafter without making use of "fence."

74. Give description and sketch showing metal fence or stair gauge.

75. Give description and sketch showing "fence and slotted square."

76. Give description and sketch showing ap-

plication of "square and fence" in laying out a "housed string."

77. Give description and show by sketches how the "square" can be used for getting the lengths and bevels for braces and regular and irregular runs.

78. What does the length of any brace simply represent, and give an example?

79. Describe how "the octagonal" scale may be applied in dressing a stick 10 inches square to an octagonal shape.

80. Describe how to find the number of inches to take on blade and tongue for a given rise and run of a brace.

81. Describe how to find a circle equal in area to two or more circles.

82. When 3 points not in a straight line are given, show how to find the center of a circle which will pass through them.

83. Describe how to find the center of a circle with a "square."

84. Describe how to find the side of a square of half the area of a given square.

85. Describe how to lay off angles of 60° and 30°.

86. Describe how to lay off an angle of 45°.

87. The hypothenuse and one side of a right-angled triangle being given, describe how to find the other, or two sides being given show how to find the hypothenuse.

88. Describe how to lay off an octagon on a given side.

89. Show how to obtain the length and bevels for an "octagon Hip-rafter."

90. Describe how to make a square stick octagonal.

91. Describe how to find an octagon when the side of the square is given.

92. When the side of the octagon is given describe how to find the square width.

93. When the square width is given, describe how to find the diagonal.

94. Describe how to find the bevels and width of sides and ends of a square hopper.

95. Describe how to find the "Backing of the Hip rafters."

96. Describe how to find the lengths and bevels of Hip rafters.

97. Describe how to find the lengths of the "Jack rafters."

98. Describe how to find "the lengths of Jack rafters on the end."

99. Describe how to find the first, the second, third and fourth pairs of hip rafters and middle jack rafter of an octagon roof.

100. Describe how to find the first, second and third pairs of hips, also the backing of the hips of an octagonal roof.

101. Give sketch of the "straining beam," the "brace" and the "tie-beam" of a roof, and describe

how to find bevel of the upper end of the brace where it butts against the straining beam.

102. Describe how the angle made between brace and straining beam is bisected.

103. Give description how "plain stairs" are constructed.

104. Describe how to find the "cuts and bevels" for a hexagonal hopper.

105. Describe how to find the "cuts and bevels" for an octagonal hopper.

106. Describe and show by sketch how to construct a "conveyor" for a flour mill, with the following dimensions: Diameter of shaft 5 inches, length 14 feet, pitch of flights or screw 7 inches.

107. Describe and show by sketch how to construct a "conveyor" with an octagonal shaft.

108. Describe and show by sketch how to find the largest rectangular stick that can be cut from a round log.

109. Give description of how a "square" may be tested.

110. Give description of what is generally known as "the American Steel square."

111. Give an example of how to use the steel square to cut a brace to support a beam or bracket.

112. Give description and sketch how to find the run of a hip, the length of the jack rafters, and the backing of hip.

113. Fig. 46, vol. 4, is a roof having three gables, each being a different pitch, the two valleys being unequal as regards run. The ridge is 8 feet

above the level or plate. Describe how to find the rafters, hip rafters, jack rafters, and all the bevels and cuts for the roof.

114. Describe how to make a step-ladder to reach a landing 8 feet high and to slope to a convenient point 4 feet 6 inches back.

115. Give description and sketch showing the method of testing the exterior angle of a steel square.

116. Give description and sketch showing how to compare the exterior angle of a steel square, with its interior angle.

117. Give description and the figures which are as large as possible, so as to reduce the possible error in measurement to the smallest possible dimensions.

118. Give description and sketch showing how by steel square to obtain the right angle or square miter, the octagon miter, and the hexagon miter.

119. Give description and sketch showing how the square may be employed to describe a circle.

120. Give description and sketch showing a handy method for determining the dimensions of the largest rectangle that can be drawn in a given circle.

121. Give an example of how "the pitch" of a roof is described.

122. Give description and sketch showing how the relationship of certain divisions of the circle to different figures on the square is indicated, or

in other words, how degrees may be obtained with the square.

123. Give description and sketch showing how to lay off an octagon on the end of a timber.

124. Show by use of the square how to miter a pentagon.

125. Show by sketch and description how to lay off "a hexagon" from a square timber.

126. Show by sketch and description how to find center of circle with the square.

127. Show by description and sketch a rapid method of dividing anything into several equal parts, by use of the square.

128. Show by sketch and description a good method of cutting bridging by use of the square.

129. Give description and sketch how to make an ellipse for a three-foot opening, one foot high, by use of square.

130. Give description and sketch how to make an oval by use of square.

131. Give description and sketch showing how to bend a board for a circle, if the given length is 2 feet.

132. Give description and sketch showing how to find the number of courses of shingles for a roof.

133. Give description and sketch showing how to cut a miter box by aid of the square for raking mouldings.

134. Give description and sketch showing how by means of the steel square to determine the

proper figures to use for making the cuts on a "third pitch" roof.

135. Give description and sketch showing how to make a miter box with cuts, by use of the square.

136. Give description and sketches showing the method how to cut the members of a raking cornice where the angle is 45°, by use of the square.

137. Give description and sketch showing how to find a line forming equal angles with two converging lines, by use of the square.

138. Give description and sketch showing how the sectional part of a circular frame or wheel may be obtained by the aid of the square.

139. Give description how to make a frame with eight equal parts, by use of the square.

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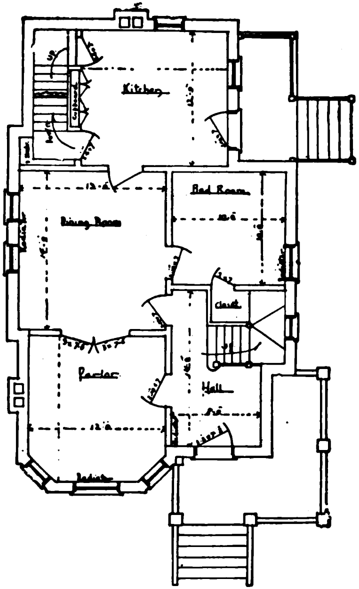
"The Riverdale"

Price of Plans and Specifications

$5.00

Full and complete working plans and specifications of this house will be furnished for $5.00. Cost of this house is about $3,500, according to the locality in which it is built.

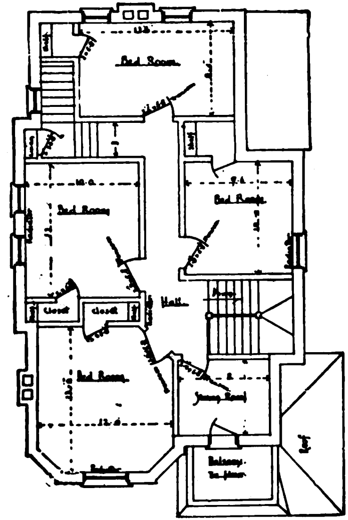
Floor Plans of "The Gopt .n"



FIRST FLOOR PLAN

SIZE

Width, 26 feet
Length, 42 feet



SECOND FLOOR PLAN

Blue prints consist of cellar and foundation plan; first and second floor plans; roof plan; front and side elevations. Complete typewritten specifications with each set of plans

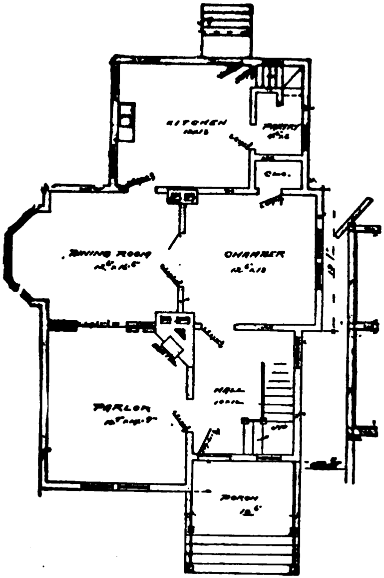
"The Eastlake"

Price of Plans and Specifications

$5.00

Full and complete working plans and specifications of this house will be furnished for $5.00.
Cost of this house is from $1,900 to $2,000, according to locality in which it is built.

Floor Plans of "The Eastlake"



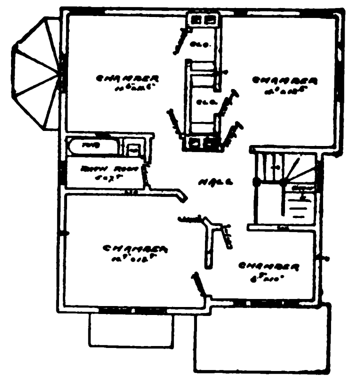
FIRST FLOOR PLAN

SIZE

Width, 32 feet
Length, 42 feet

Blue prints consist of cellar and foundation plan; floor plans; front and side elevations.

Complete typewritten specifications with each set of plans.

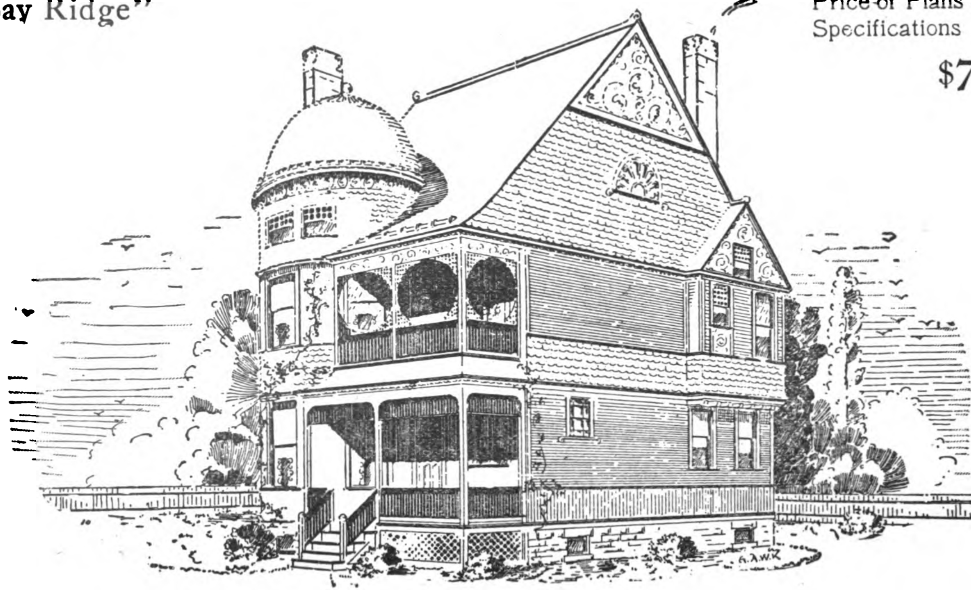


SECOND FLOOR PLAN

"The Bay Ridge"

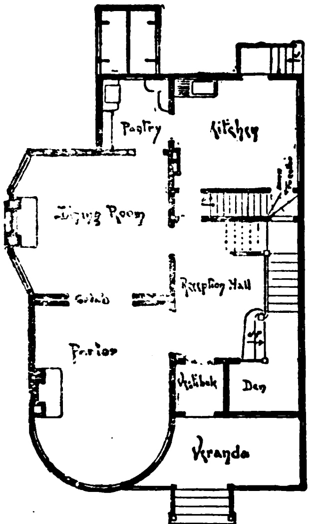
Price of Plans and Specifications

$7.50



Full and complete working plans and specifications of this house will be furnished for $7.50. Cost of this house is from $3,700 to $4,000, according to the locality in which it is built.

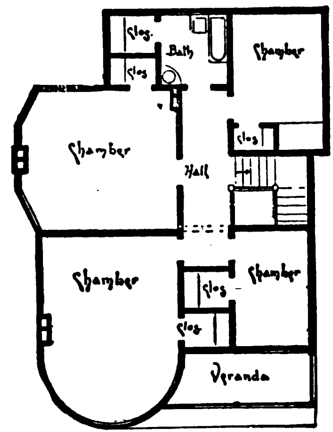
Floor Plans of "The Bay Ridge"



First Floor

SIZE

Width, 30 feet
Length, 42 feet



SECOND FLOOR

Blue prints consist of cellar and foundation plan; roof plan; floor plans; front and side elevations.
Complete typewritten specifications with each set of plans.

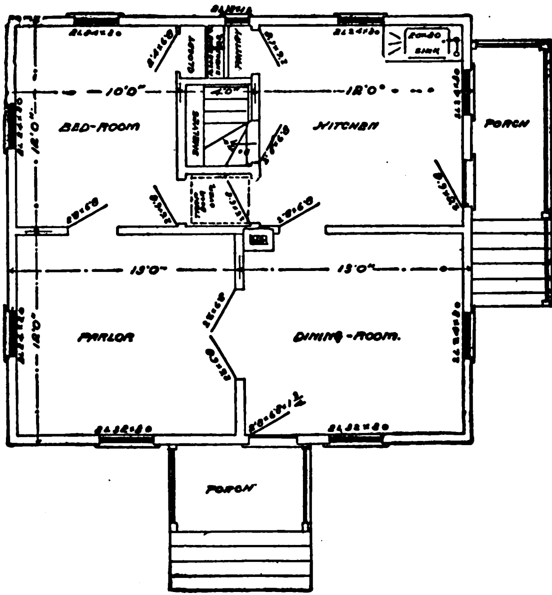
"The Flora"

Price of Plans and Specifications

$5.00

Full and complete working plans and specifications of this house will be furnished for $5.00. Cost of house is from $1,050 to $1.150, according to the locality in which it is built.

Floor Plan of "The Flora"



SIZE
Width, 24 feet
Length, 26 feet

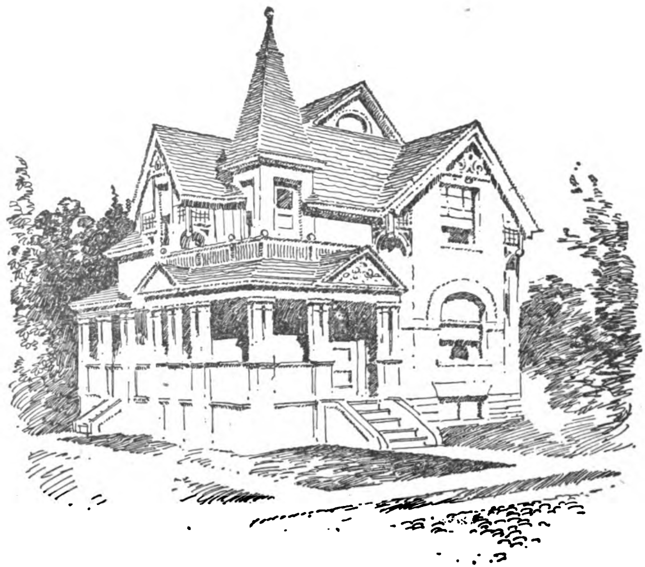
Blue prints consist of cellar and foundation plan; floor plan, roof plan; front and side elevation.

Complete typewritten specifications with each set of plans.

"The Greenwood"

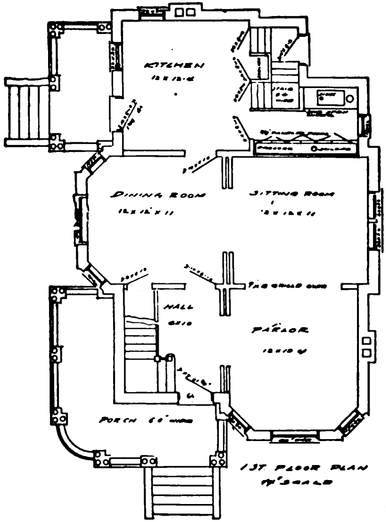
Price of Plans and Specifications

$5.00



Full and complete working plans and specifications of this house will be furnished for $5.00.
Cost of this house is from $1,800 to $2,000, according to the locality in which it is built.

Floor Plans of "The Greenwood"



SIZE:

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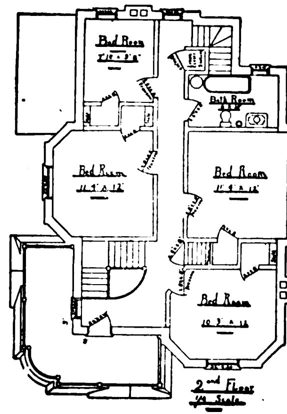
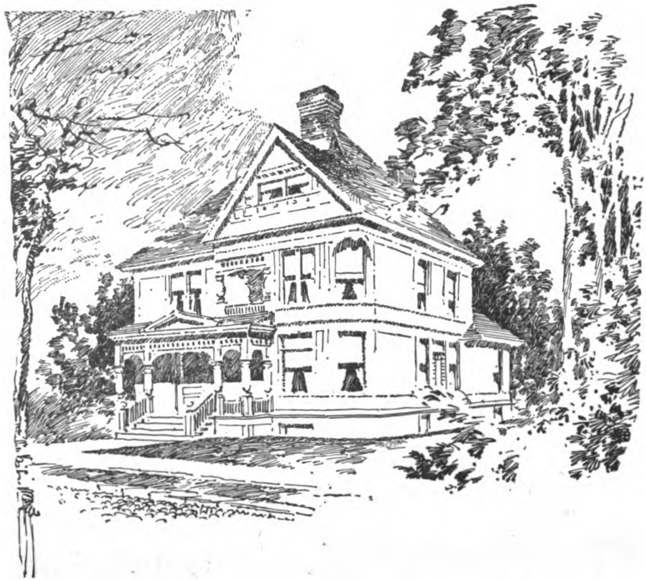
Length, 44 Feet



Blue prints consist of floor plans; roof plan; front and side elevations.
Complete typewritten specifications with each set of plans.

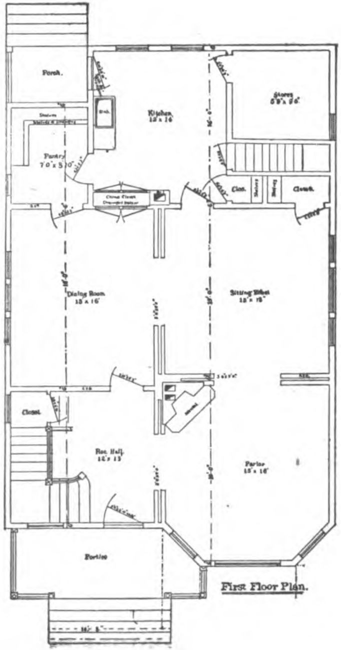
"The Riverdale"

Price of Plans and Specifications
$5.00



Full and complete working plans and specifications of this house will be furnished for $5.00. Cost of this house is about $3,500, according to the locality in which it is built.

Floor Plans of "The Riverdale"



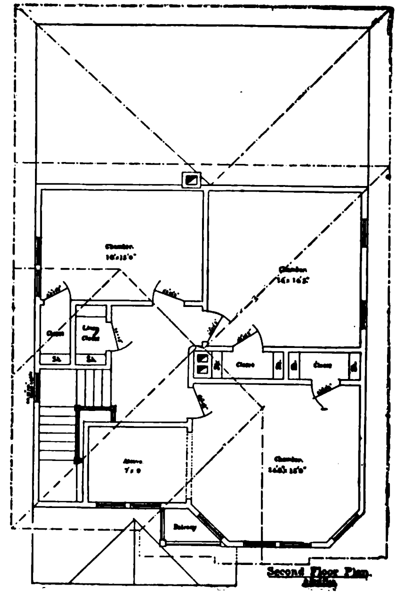
First Floor Plan.

SIZE:

Width, 30 feet
Length, 58 Feet

Blue prints consist of cellar and foundation plan; floor plans; roof plan; front and side elevations.

Complete typewritten specifications with each set of plans.

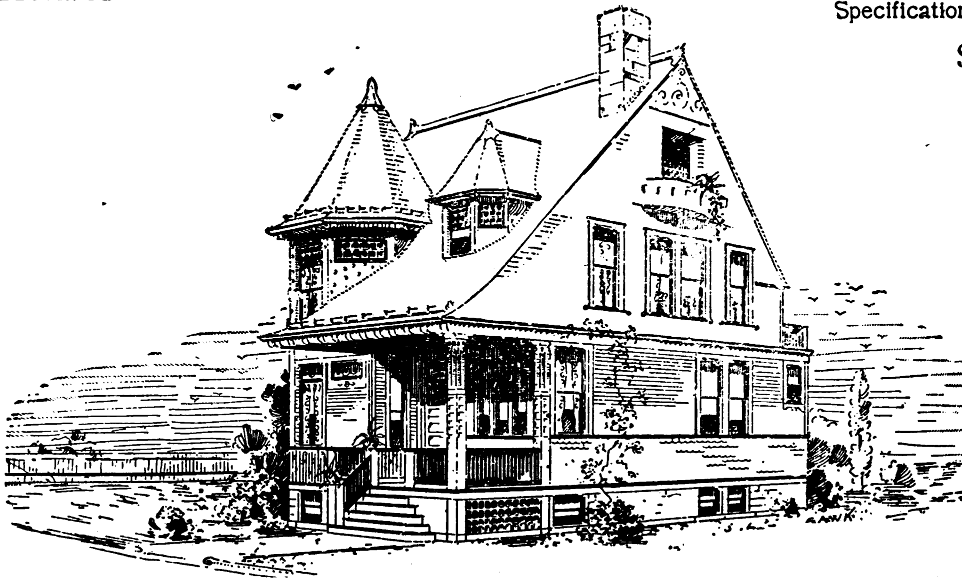


Second Floor Plan.

"The Holland"

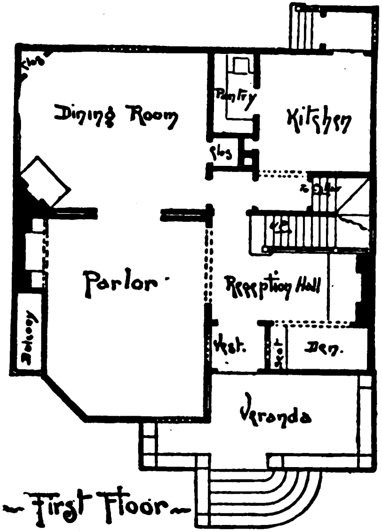
Price of Plans and Specifications

$7.50



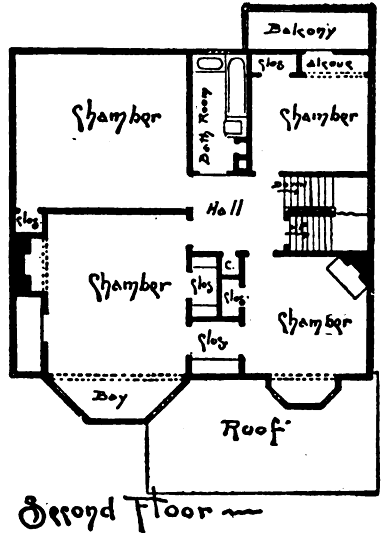
Full and complete working plans and specifications of this house will be furnished for $7.50.
Cost of this house is from $3,500 to $3,600, according to the locality in which it is built.

Floor Plans of "The Holland"



SIZE

Width, 33 feet
Length, 42 feet



Blue prints consist of cellar and foundation plan; floor plans; roof plan; front and side elevations. Complete typewritten specifications with each set of plans.

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Ford Motor Car and Truck and Tractor Attachments	*Cloth	1.00
Automobile Catechism and Repair Manual	*Lea.	1.25
Practical Gas and Oil Engine Handbook	*Lea.	1.50
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